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Economic value of tideland as place for recreational clam digging, a case study at Kajishima Island

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Abstract Clam digging produces large revenue for fishery cooperative associations and produces a large additional income to fishermen. Although many urban residents enjoy clam digging, an evaluation of the economic value has not been carried out until now. Therefore, I estimated the recreational benefits of clam digging by the travel cost method by using the embarkation lists of the ferryboats for recreational clam digging visitors at Kajishima Island, Kira Town. The results totaling 35.65 million yen were calculated as the recreational benefits of Kajishima Island's surroundings of about 6 ha from the clam digging bed. This amount with Manila clam fishing amount of the Kira Fishery Cooperative Association of 38 million yen. It is evident that urban residents gained a large benefit from recreational clam digging. Mitigation by artificial tidal land is necessary for the tidal land lost by land reclamation as a future policy.

Key words: clam digging, recreational benefits, travel cost method

Among various important uses of tideland such as purification of water and nursery of aquatic animals, the function as a place for recreation and tourism should not be disregarded. Clam digging has been traditionally major recreation performed on tideland in Japan. Manila clam is dominant species caught by recreational clam digging. However, the catch of Manila clam in Japan by commercial fisheries has been decreasing recently and recreational clam digging is no longer carried out in many areas depending on only local resources. Many fishermen's cooperative associations are releasing recently seeds of Manila clam along their coast to compensate the decrease, and to continue clam digging habit. Under this situation, estimation of economic value is becoming important though there is no research on the economic value of clam digging except the report by Aoyama *et al.* (1996), which considers the value from the view point of water purification function. In this study, I estimate the economic value of clam digging in Kajishima Island as a case study.

1. Present status of clam digging in Kajishima Island.

Kajishima is located in Mikawa Bay facing to Miyazaki Port, Kira City, Aichi, Japan. The shore line of the Kajishima Island is 1.8 km and the distance between Miyazaki port and Kajishima Island is 1.5 km. The nearest large city is Nagoya City and distance between Miya-zaki Port and Nagoya is 50 km and 1.5 hours by car. The shore where clam digging is possible is about 2/3 of the circumference of the island. An area of the clam digging ground is estimated at about 6 hectares. Most of clam digging grounds of this island are shores which have many stones instead of a tideland of a sandy area. Manila clams live in the sand which occurs between these stones (Fig. 1). Clam

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digging in Kajishima Island is administrated by Kira Fishermen's Cooperative Association (KFCA). KFCA operates 14 small trawl net fishing boat as transportation between Miyazaki Port and Kajishima Island during the season. The price of round ticket by boat between Miyazaki port and Kajishima is 1,100 yen and tourist for clam digging in Kajishima Island pay 1,200 yen as a charge for clam digging to KFCA. The passenger on the boat has obligation to fill up the passenger list with their name and address. A net is handed to a tourist as the payment of clam digging charge and a tourist can catch the clam up to the limit of the volume of the net. A net can accommodate about 10kg of clam.

Aside the income of clam digging charge, KFCA collect 8 % of the boat charge, 5 % as catch commission and 3 % as Manila clam seed price from the captains of trawl net fishing boats.

2. Present status of Manila clam fishery and recreational clam digging

Aichi prefecture had recorded the highest catch among prefectures in Japan for 14 years until 2000 except 1995 (Fig.2). The amount of the catch by Manila clam fisheries in Aichi Prefecture decreased after the peak in 1989 (Fig.3). Table 1 shows the number of people who visited shore of prefectures for recreational clam digging from fisheries census in 1998. Nine hundred and ninety five thousand people visited the shore of Kanagawa Prefecture and this was the highest record of visitors in 1998. Less than half of the highest record visited to coast of Aichi Prefecture (424,000). This number attributes to 10 % of total number in Japan. Recreational clam digging in Aichi is supported by fishermen's cooperative associations. There are many fishermen's cooperative associations that have the section for recreational clam digging service. They release 18×10^8 Manila clam seeds (57 % of total released seed in Japan) for stock enhancement and more than 80 % of tourist who came to shore of Aichi for clam digging used the guidance by fishermen's cooperative associations (Table 2).

Table 3 comes from investigation of fishermen's cooperative associations. Table 3 is showing management rules and present status of clam digging controlled by 13 fishermen's cooperative associations in central part of Mikawa Bay, from Gamagouri City to Isshiki Town. The seasons for recreational clam digging and number of visitor differ among fishermen's cooperative associations. The lowest number of visitors is 679, and highest number of visitors is 70,000. The quantity of released seed ranged

Fig. 1. Kajishima-island clam digging spot

Table 1. Number of clam digging visitors

Prefecture Name	Number of clam digging visitors (total)	Number of clam digging visitors who used guidance of fishermens' cooperative associations
Kanagawa	995,000	5,000
Mie	734,800	260,500
Chiba	652,800	480,800
Aichi	424,100	395,200
Ibaraki	396,600	0
Okinawa	178,000	1,600
Hyogo	167,300	138,700
Hiroshima	117,900	26,100
Shizuoka	117,000	74,300
Kagoshima	103,200	0
Wakayama	86,700	82,800
Oita	79,600	21,000
Osaka	64,300	0
Kumamoto	54,700	9,100

Source: Fishery Census (1998)

from 1 to 126 ton. The coefficient of correlation between the number of visitors and the quantity of seed released was high with 0.888. In other words places with many visitors correlate with high seed release. The charge for adult varies from 900 to 1,400 yen. The highest price is 2,300 yen when the ferryboat charge is added. The upper limit of catch allowed to visitor is from 2 to 10kg, and some places are allowed to catch clams without limit.

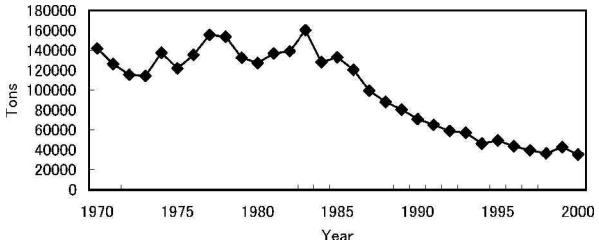

Fig. 2. The change of total catch by Manila clam fishery in Japan Source: Fishery Statistics

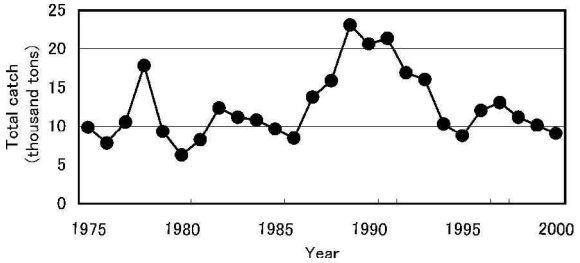

Fig. 3. The change of total catch by Manila clam Fishery in Aichi Source: Fishery Statistics

Table 2. Number of Manila clam seed released

Prefecture Name	1998 (billion)
Aichi	18.08
Mie	2.9
Chiba	2.43
Yamaguchi	1.88
Kumamoto	1.48
Fukuoka	1.24
Oita	1.07
Shizuoka	0.9
Nagasaki	0.68
Miyagi	0.55
Fukushima	0.21
Hiroshima	0.08
Hyogo	0.06
Ehime	0.03
Others	0.09

Source: Fishery Census (1998),

Method

I estimate economic value of recreational clam digging for KFCA and fishermen who carry visitor by fishing boat. I estimate recreational benefits of recreational clam digging for visitors by using travel cost method. The passenger list of boat transportation between Miyazaki Port and Kajishima Island was used in the estimation of number of visitor and specification of address of each visitor. I estimate travel cost (TC) of each visitor by summing up their monetary expenses and time expenditure. In the estimation of travel cost, necessary time and distance were calculated by assuming that each visitor came from their municipality office and they used toll way when the distance exceed 100 km. In the estimation of traffic expenses, rate of fuel consumption is 15 yen a km. Monetary expenses include a traffic expenses, a toll, the price of round ticket by boat between Miyazaki Port and Kajishima and a charge for clam digging to KFCA. In the estimation of time expenses, opportunity expenses of round trip and clam digging were calculated by using of average wages rate. I estimate visit rate (V) by using each population of municipality and visitor's number of each municipality. I estimate relational expression between TC and V. I estimate visitor's number of each municipality by using this relational expression and TC. I sum up by 500 yen to the TC of each municipality until visit rate down to 0. I sum up visitor's number of each municipality by an additional expenses (TC'). I calculate acceptable rate (V') of each TC'. I estimate relational expression between TC' and V'. I can find the visitor's average recreational benefit by integrating this equation.

Table 3. Aichi clam digging enforcement situation comparison

	Period for clam digging in 2002	Charge for adult (yen/ indiv. /day)	Limitation of catch for adult (kg/ indiv.)	Charge for child (yen/ indiv. /day)	Limitation of catch for child (kg/ indiv.)	Ferryboat charge (yen/ indiv.)	Amount of Manila clam seed released (ton/-year)	Accommodation number of a parking	Charge for parking (yen/car)	Number of visitor a year (2000 or 2001)
A	2/28～6/27	1,200	5	600	2.5	-	1.0	150	0	679
B	2/28～6/27	2,000	5	1,000	2.5	800	3.2	-	-	1,096
C	3/28～6/16	900	2	900	2	-	60.8	400	400～500	25,000
D	3/1～5/30	1,200	4	700	2	-	13.0	80	0	2,602
E	3/17～7/29	1,400	4	700	2	-	126.0	2,000	0	70,000
F	3/17～7/29	2,100	4	1,400	2	700	18.0	-	-	10,000
G	3/1～7/28	1,400	4	700	2	-	28.0	300	0	9,482
H	2/28～6/25	1,400	10	700	5	-	46.0	500	0	3,300
I	2/28～6/23	2,300	10	1,500	5	1,100	50.0	-	-	11,000
J	3/14～6/16	1,300	unlimited	700	unlimited	-	60.3	500	0	15,263
K	3/1～6/29	1,000	unlimited	500	unlimited	-	8.5	1,000	0	10,335
L	4/beg.～6/beg.	1,000	unlimited	500	unlimited	-	2.0	1,000	0	2,000
M	3/16～5/31	1,200	5	600	3	1,600	40.0	-	-	4,700

Source: Information from fishery cooperative associations

Results

1. Economic value of recreational clam digging for KFCA

The fiscal year of the KFCA begins in May and is over in April, the season of clam digging is divided into two financial years. The income of the KFCA in 2001 was 14.66 million yen from the recreational clam digging visitors and 1.43 million yen from the fees from the ferryboat fishermen. As for the outgoing of the KFCA, the Manila clam seed price for release was the biggest expenditure with 6.25 million yen, and wages were 490 thousand yen, and the enterprise profit that subtracted the outgoings from the incomings was 9.36 million yen (KFCA, 2001)(Table 4). In addition, a subsidy of about 3 million yen is expended to the seed price from Kira Town.

Table 4. An enterprise effect by recreational clam digging in the Kira Fishermens' Cooperative Association from 1 May 2000 to 30 April 2001

(units: million yen)

Income	
The income from recreational digging	14.66
The income from the ferryboat fishermen	1.44
Expenses	
Seed release expenses	6.25
Wages for watchmen	0.49
Profit	9.36

Sources: KFCA, 2001 and hearing investigation from KFCA

2. Economic value of recreational clam digging for fishermen who ferry visitor by fishing boat

Clam digging was carried out for 32 days from 24 March to 24 June in 2001 in Kajishima Island. The number of embarkation persons last year (2001) was 7,276, there was about 8 million yen income for fishermen from adult recreational diggers. Fishermen paid 8 % of income to the KFCA. And it was 525,971 yen income for a vessel a season.

3. Economic evaluation of the recreational benefits for visitor from recreational clam digging in Kajishima Island by travel cost method

Clam digging visitors came from 17 prefectures, but 88 % were from Aichi Prefecture (Table 5). Nagano and Gifu accounted for around 4 %. In Aichi Prefecture, Kira Town occupy 11 %, and Okazaki City 10 %, Nagoya

Table 5. Clam digging visitors from various prefectures

Prefecture	People	Percent
Total	7,276	100.0
Aichi	6,432	88.4
Nagano	312	4.3
Gifu	261	3.6
Mie	62	0.9
Shizuoka	50	0.7
Yamanashi	28	0.4
Kanagawa	22	0.3
Ishikawa	15	0.2
Tokyo	14	0.2
Osaka	5	0.1
Saitama	4	0.1
Niigata	4	0.1
Shiga	3	0.0
Fukui	3	0.0
Kyoto	2	0.0
Gunma	2	0.0
Chiba	2	0.0
Unknown	55	0.8

Source: Embarkation list of 2001

City Minato Ku 7 %, Nishio City 7 %, Gamagoori City 5 %, Toyota City 5 % rank high (Table 6).

(1) Monetary expenses

I include the clam digging charge of 1,200 yen, ferryboat charge of 1,100 yen and traffic expenses for monetary expenses. I could specify 7,221 addresses that came from 187 municipalities from the embarkation list. The measurement of distance from each municipality's government office to the Miyazaki Fishing Port was taken from the motoring distance with commercial map software. The measurement of money of road toll uses the map software, too. Because I used adult charge, it is calculated to raise it slightly because there were some children diggers. In addition, because for the embarkation person from Kira Town, as many visitors from Miyazaki District traveled on foot no charge for transportation was assumed and I assumed that visitors from other districts came by car and used the distance from a Kira Town Government Office to Miyazaki Fishing Port. Family groups were assumed to travel together and the expenses

Table 6. Clam digging visitors by municipality of Aichi Prefecture

Municipality	People	Percent
Total for Aichi Prefecture	6,432	100.0
Kira Town	710	11.0
Okazaki City	645	10.0
Nagoya City Minato Ku	459	7.1
Nishio City	453	7.0
Gamagoori City	342	5.3
Toyota City	310	4.8
Anzyou City	278	4.3
Hekinan City	177	2.8
Tiryu City	167	2.6
Hazu Town	163	2.5
Handa City	152	2.4
Kasugai City	147	2.3
Kariya City	144	2.2
Nagoya City Midori Ku	132	2.1
Toyohashi City	126	2.0
Nagoya City Nakagawa Ku	119	1.9
Nagoya City Minami Ku	99	1.5
Kisogawa Town	87	1.4
Toyoake City	84	1.3
Ohbu City	80	1.2
Nagoya City Kita Ku	72	1.1
Tohkai City	69	1.1
Kohta Town	64	1.0
Isshiki Town	63	1.0
Chita City	60	0.9
Ichinomiya City	59	0.9
Nagoya City Tenpaku Ku	59	0.9
Taketoyo Town	57	0.9
Nagoya City Moriyama Ku	56	0.9
NagoyaCity Mizuho Ku	56	0.9
Komaki City	53	0.8
Miyoshi Town	51	0.8
Others of Nagoya City	266	4.1
Others of Aichi Prefecture	573	8.9

Source: Embarkation list of 2001

averaged for the number of people and, about all the municipalities, calculated the amount of average one person and weighted average of them and calculated the average transportation expenses for each municipality. By the travel cost method, it does not exclude a person having other purpose of trip, and thus it may overestimate. However, the outskirt of Kajishima Island and Miyazaki Fishing Port do not have any other big recreation facilities elsewhere. I judged the purpose of embarkation visitors only for clam digging so that it was necessary

for visitors who gathered clam at low tide to take home live clams with them because most visitors return home after clam digging immediately.

(2) Time expenses

I measured tour time to the Miyazaki Fishing Port from the municipality office of residence of each embarkation person by map software. Furthermore, I applied tour times to have made use of an expressway in case that they exceed 100 km one way. The necessary time for clam digging is 3 hours and 30 minutes. I multiplied for the expenses rate in an opportunity of a tour time for the total in the aforementioned necessary times. I used an average wages rate R in the following equation as an expenses rate in an opportunity of a tour time (Fujimoto, 1996).

$$R=(w\times(1-T)/Hw)\times(E/M) \quad (1)$$

Where w is average monthly cash earnings for regular employee by prefecture (establishments with 30 employees or more) (Statistics and Information Department, Ministers' Secretariat, Ministry of Health, Labor and Welfare, Japan, 2002). The term T is tax ratio against each prefecture inhabitant of a prefecture income (Government Cabinet Prefecture, 1998, Local Public Finance Investigation Research Society, 1999 and National Tax Agency, 1999). The term Hw is average monthly hours worked by a regular employee at prefecture (establishments with 30 employees or more) (Statistics and Information Depart-ment, Ministers' Secretariat, Ministry of Health, Labor and Welfare, Japan, 2002). The term E is the number of persons who work in one household with each prefecture office location city (Statistics Bureau, Ministry of Public Management, Home Affairs, Posts and Telecommunications, Japan, 2001)

The term M is the number of persons in one household with each prefecture office location city (Statistics bureau Ministry of Public management, Home Affairs, Posts and telecommunications, Japan, 2001)

I summed up aforementioned monetary expenses and time expenses and calculated the travel cost (TC) for one person for each municipality.

(3) Visit rate (V)

I estimate V (percentage) from the following formula. Divide visitor's number of each municipality by each population of municipality (thousand persons).

(4) Calculation of equation of V and TC

Because I applied function style by the least-squares method in respect of scattering of V—TC, applying to it indeed for natural logarithm equation was good. The relation between V and TC can be expressed by the following equation. (Fig. 4)

$$V=-181.496\log TC+1808.978 \quad (2)$$

The P value was 0.000113 and meaningful though the decision coefficient is low with 0.08.

(5) Estimation of visitor number of each municipality.

I calculated the estimated V of aforementioned equation based on TC for each municipality. Then I found the estimation number of visitor for each municipality.

(6) Measurement of the additional expenses (TC') and accept rate (V')

I added additional expenses until an estimation visitor number became 0 by 500 yen for TC every municipality. Because I applied function

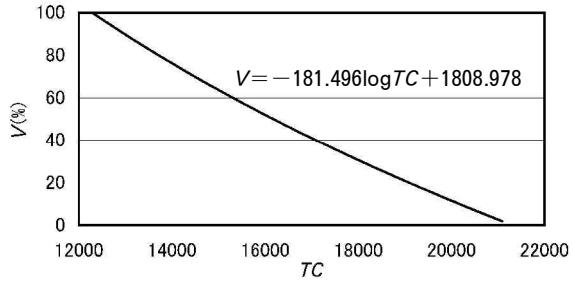

Fig.4. The relation between V and TC

style by the least-squares method in respect of scattering of $V'-TC'$, applying to it indeed for natural logarithm equation was good. Relation between the additional expenses (TC') and the accept rate (V') can be expressed by the following equation.(Table 7 and Fig.5)

$$V'=-0.33809\log TC'+3.239559 \quad (3)$$

The value P was 1.21×10^{-19} and meaningful with a 0.954 decision coefficient.

(7) Calculation of the average *WTP* (willingness to pay)

If I decide demand curve of equation (3), integrate it, I can calculate the average *WTP*.

$$WTP=\int_a^b (-0.33809\log\ TC'+3.239559)\,dTC'$$

a: 0

b: 14,077 yen (accepting 1 percent)

The average *WTP* for a person was 4,900 yen by this equation.

(8)Estimation of the recreation benefits

Average *WTP* 4,900 yen × 7,276 person = 35,650,000 yen

Recreation benefits of visitor at Kajishima Island estimated 35.65 million yen.

Discussion

Because of the enterprise, general profit of the KFCA in 2001 was about 42 million yen, and the profit from recreational clam digging accounts for 22 % of general profit, and its benefit in the KFCA is high. Clam digging is carried out in a lot of fishermen's cooperative associations in Mikawa Bay, and an enterprise profit of a fishermen's cooperative association plays an important role.

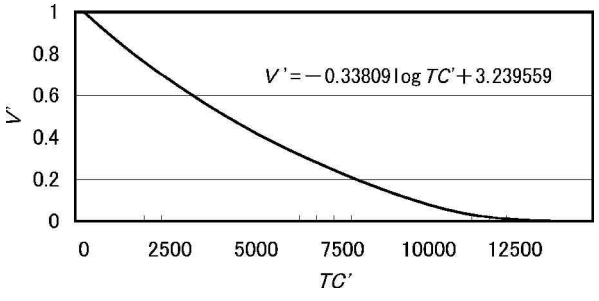

Fig.5. The relation between V' and TC'

At Kira Town, fishermen carry clam digging visitors after their trawling operation, so the pickup income is added to a fishing income. Because the unloading of a small trawl net of 2001 was about an average of 7.5 million yen, the pickup income comprises around 7 %. However, as for the fishery income, pickup income (525,971 yen) amount to the 23 % for 2.3 million yen by unloading 7.5 million yen. It became clear that clam digging brings large additional income to fishermen who carry visitors.

Recreational benefits of clam digging for

Table 7. Measurement of the additional expenses (TC') and accept rate (V')

TC' (Additional expenses (yen/indiv.))	Estimated number of accepted person of all municipalities	V' (Accept rate)
0	13,530	1.0
500	12,550	0.92759
1,000	11,616	0.85856
1,500	10,733	0.79332
2,000	9,906	0.73216
2,500	9,114	0.67361
3,000	8,359	0.61779
3,500	7,638	0.56454
4,000	6,958	0.51426
4,500	6,309	0.46633
5,000	5,694	0.42086
5,500	5,122	0.37856
6,000	4,580	0.33853
6,500	4,069	0.30073
7,000	3,576	0.26433
7,500	3,102	0.22925
8,000	2,642	0.19528
8,500	2,222	0.16422
9,000	1,821	0.13457
9,500	1,455	0.10751
10,000	1,103	0.08152
10,500	802	0.05927
11,000	561	0.04147
11,500	368	0.02718
12,000	226	0.01667
12,500	123	0.00909
13,000	54	0.00397
13,500	23	0.00172
14,000	9	0.00070
14,500	2	0.00016

visitors are estimated 35.65 million yen at Kajishima Island. This amount of money is almost equal to 38 million yen of quantity of Manila clam fishery of 151 tons a year in the KFCA. It is obvious that urban residents give a high evaluation against recreational benefits of clam digging.

A lot of city inhabitants enjoy clam digging as natural scene or object which adds to poetic charm to the season, but, on the other hand, a tendency to decrease Manila clam population, and an expense of seed discharge rises, too. In addition, landfill goes ahead through a tideland of the coast, and fishing grounds of clam digging are being lost. For example, large quantities of Manila clam died by high water temperature and an outbreak of blue tide in Mikawa Bay in 1994. And a red tide by Heterocapsa occurred on the coast that reached Gamagoori City from Issiki-town in summer, 2000, and Manila clam died in large quantities (Sonda and Kimura ., 2001). Clam digging was canceled due to shellfish poisoning which occurred in spring, 2001, until a declaration of safety came out on 19 March, and, it is a grave concern.

I estimated the recreational benefits of clam digging at 35.65 million yen as the recreation benefits of about 6 hectares Kajishima Islands' clam digging ground. It became clear that the recreational benefits of clam digging for city inhabitants were equivalent to the fishery amount of money and the scale.

Maintenance of the water quality is important, but in fact the water purification ability of a tideland where clam digging is possible is the most effective for the improvement of the water quality, and enhancement of artificial tidal land is necessary for the tidal land lost by land reclamation as a future policy so that we can continue clam digging in future. I would like to do such an economic assessment of tideland to judge whether the budget expenditure is right or not when a country and a local self-governing body enforces mitigation and supports clam digging. In addition, producer of the artificial tideland must not make the new environmental disruption by collection of sand to make the tideland.

The number of people digging clam according to prefecture by a fishery census, Kanagawa Prefecture was the first place, but most people are the people who came to the Park of the sea which is an artificial tideland made in reclaimed land of Kanazawa-ku, Yokohama City, Kanagawa Prefecture. But there is not management by fishermen's cooperative associations, and indiscriminate gathering becomes a problem because there is not fishery right in the Park of the sea (Kudou, 2000). It is thought that the role of management by the fishermen's cooperative associations in a clam digging fishing ground is very important.

References

Aoyama H., Imao K., and Suzuki T., 1996: Function that a tidal land purifies a quality of water—As doing Issiki tidal land for an example—. *Kaiyo Monthly*, **28**(**3**), 178-188.(In Japanese)

Fujimoto T., 1996: Economic evaluation of agricultural externalities—An Application of Contingent Valuation Method—. *Bulletin of the Nara Prefectural Agricultural Experiment Station*, Special research, 59-62. (In Japanese)

Government Cabinet Prefecture, 1998: Prefectural economy calculation annual report. (In Japanese)

Kira Fisheries Cooperative Association., 2001: Heisei Year 12 Business Report, 17pp. (In Japanese)

Kudou T., 2000: Manila clam digging problem at a beach where resource manager is absent, *Coastal Zone*, **13**(**1**), 53-57. (In Japanese)

Local Public Finance Investigation Research Society, 1999: Prefectural settlement of accounts situation survey. (In Japanese)

National Tax Agency, 1999: Statistical annual report on the national taxes. (In Japanese)

Sonda Y. and Kimura H., 2001: Occurrence of

Heterocapsa circularisquama red tide in Mikawa Bay, 2000. *Bulletin of the Aichi Fisheries Research Institute*, **8**, 1-6. (In Japanese with English abstract)

Statistics and Information Department, Ministers' Secretariat, Ministry of Health, Labor and Welfare, Japan, 2002: Annual report on the monthly labor survey Prefectural Survey, 22pp. and 42pp. (In Japanese)

Statistics Bureau Ministry of Public Management, Home Affairs, Posts and Telecommunications, Japan, 2001: Annual report on the family income and expenditure survey, 304pp. (In Japanese)