Asian Fisheries Science **8** (1995): 255-262
Asian Fisheries Society, Manila, Philippines
https://doi.org/10.33997/j.afs.1995.8.3-4.008

Freshwater Fisheries of Cambodia, I: The Bagnet (Dai) Fishery in the Tonle Sap River

S. LIENG and C. YIM

Department of Fisheries
Ministry of Agriculture, Forestry and Fisheries
Phnom Penh, Cambodia

N.P. VAN ZALINGE

Mekong River Commission
P.O. Box 582
Phnom Penh, Cambodia

Abstract

The bagnet or dai fisheries are seasonally operated in the Tonle Sap River and contribute significantly to the freshwater capture fisheries production of Cambodia. The fisheries exploit largely the current years' crop of small fish species migrating out of flooded areas around the Great Lake and Tonle Sap River to the Mekong River. Migration is strongly influenced by the lunar phase. No reliable data on catches and species are available. A special sampling program de-signed using data collected during part of the last season is presented here.

Introduction

The Tonle Sap River connects Cambodia's Great Lake and the Mekong River (Fig. 1). It joins the Mekong in Phnom Penh, where the Mekong splits into two branches, the Mekong proper and the Bassac. A remarkable hydrological phenomenon takes place during the annual flooding of the Mekong River: when pushed by the enormous quantities of water transported down the Mekong, the Tonle Sap River changes direction and flows upstream to the Great Lake for about 3 months, until the floods subside and the river resumes its normal course.

The bagnet or dai fishery is located in the lower part of the Tonle Sap River 4-30 km north of Phnom Penh. It is one of the large-scale inland water fisheries of Cambodia. According to official 1995 fishery statistics of the Department of Fisheries (DOF), the dai fishery has in recent years contributed 10-20% to the total annual inland fish production of 65,000-75,000 t. However, fishery data in general are limited and unreliable, as estimates are often based on outdated methodologies (FAO 1994). Therefore, a new approach is required on a country-wide scale. To facilitate the design of a new data collection scheme,

preliminary low frequency data collection has been carried out. The dai fisheries were sampled from December 1994 through February 1995. Results and a new sampling design are presented here.

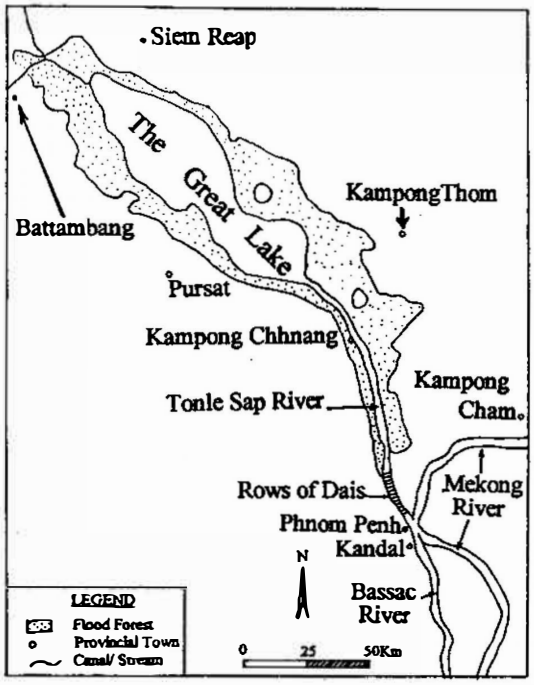

Fig. 1. Map of the Great Lake, Tonle Sap and Mekong River System, Cambodia.

Hydrological and Biological Aspects

The reversal of the Tonle Sap River flow normally takes place in July and, as a result, water depth increases greatly. The average water level in the Great Lake is about 1 m in April and increases to over 9 m during the peak of the floods (Mekong Secretariat 1993). The surface areas of the lake and the river expand three to five times in size, covering the belt of flood forests, degraded forests and wetlands surrounding the lake and river.

Fish migrating upstream invade these inundated areas for feeding and reproduction. Biological productivity is at a peak in this period. In September/ October, a second flow reversal occurs and the Tonle Sap River starts flowing once more from the Great Lake to the Mekong River. As the water level decreases, fish migrate back to the lake and river. First the dai fisheries start operating, followed by other large-scale fisheries using filtering devices, such as barrier traps, lake fences and traps (*lob nor*).

The hydrological cycle is mirrored in the biological cycle. Many species tend to spawn around the onset of the floods and their fry enter the food-rich wetlands with the floodwaters. Other species use the flooded plains and forests

for reproduction and also as nurseries. Most productive among these are the so-called opportunists - small, fast-growing and prolific species that feed low in the food chain. Large numbers migrate back to the river when floods recede from October through February. Migration usually peaks in December and January, especially in a time-window from 6-1 d before full moon, when the river seems packed solid with fish. At that time we observed catch rates of up to 38 t per dai unit in 24 h, compared to a few hundred kilogram per day during the rest of the month. The catch was found to contain mainly opportunists, but species of "white" fish (larger migratory fish) were also present.

Collection of water level data (daily gauge height readings) from stations along the Tonle Sap River has been irregular. Kampong Chhnang data go back to 1924, but there are many omissions. A declining trend in flood levels is apparent from 1957 (Fig. 2). However, the Mekong Secretariat (1993) suggests that the position of the measuring gauges has changed in this period and thus, that the lower levels after 1957 are not directly comparable. Local sources confirm that for an unknown period until 1994, water levels in Kampong Chhnang were measured using the steps of a staircase leading to the river. In 1994, new gauges were established and the flood level recorded in October 1994 was indeed in the pre-1957 range of fluctuations. Apart from these deviations, Fig. 2 shows that water levels vary from year to year within a range of 2 m. The extent of the inundated area clearly varies with the level and duration of the floods, but reliable data on area coverage do not exist. The Mekong Secretariat (1993) has shown that there is a strong correlation between the volume of water entering the Tonle Sap (and thereby the Great Lake) and the magnitude of the Mekong flood. Thus, a decrease in the average level of the Mekong floods (e.g., through the cumulative effect of dams) would lead to less water reaching the lake and less area being inundated, which would have a negative effect on fish production.

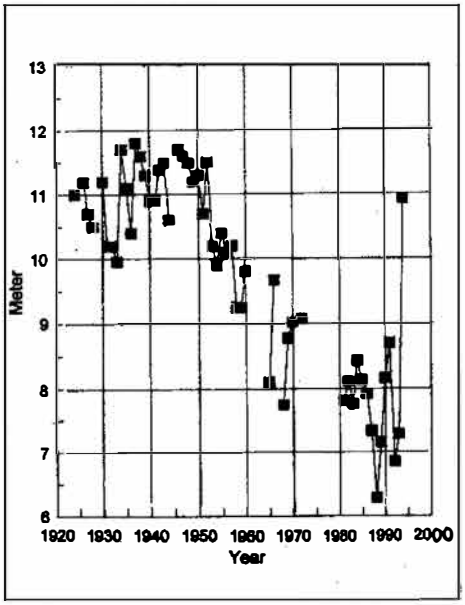

Fig. 2. October water levels of the Tonle Sap River in Kampong Chhnang from 1924 to 1994. (Courtesy Mekong Secretariat and Kampong Chhnang Hydrology Station.)

Bagnet or Dai Gear and Operation

Dai units are operated singly, but are joined with three to eight others in rows across the river, which sometimes form large barrages that leave just enough space for navigation. Altogether there were 73 dais in 15 rows operating during the 1994-95 fishing season. This number was reduced to 63 in the new season.

Two bamboo rafts about 25 m apart are linked together by bamboo poles and held stationary by anchors in the river. A sampan is placed between them, ensuring stability to the whole structure (Fig. 3). A cone-shaped net is placed in the water between the two rafts by ropes. Its mouth diameter is 25 m and the net is 120 m long. Mesh size is 15 cm at the entrance and 1 cm at the bag. When catches are low, an open-weave basket made of bamboo and rattan is attached to the last part of the bag. Another raft with platform and sampan is situated downstream at the level of the bag, which can be winched onto the wooden platform where the catch is deposited for sorting.

The dai is kept open by the force of the water current and with the help of anchors and two vertical bamboo poles fixed to the rafts. Fish moving downstream with the receding floodwater enter the net. When migration of fish is at its peak, the bag is emptied every 15-20 minutes day and night, and may hold up to 500 kg of fish per lift. But on days when few fish are migrating, the frequency of lifting is much less.

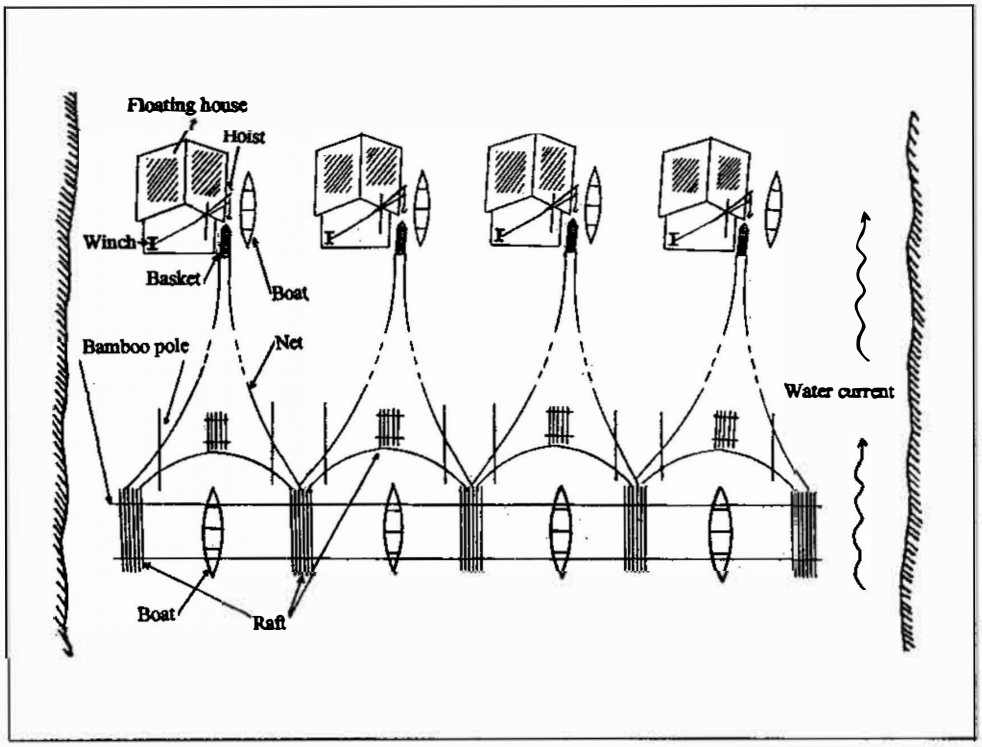

Fig. 3. Diagram of a row of four dai units in the Tonle Sap River, Cambodia.

Auction System and Fish Handling Practices

Under Cambodian fishery law, a bagnet or dai unit is classified as a fishing lot. Fishing lots are concessions auctioned by the government to the highest bidder for exclusive exploitation over a 2-year period. It is one of the government's instruments for extracting a resource rent from fisheries.

The auction is overseen by a committee consisting of the director of the central fishery department, the governor of the province and the provincial finance director. Prior to the bidding, interested parties must deposit an amount equal to one third of their initial written offer, which has to exceed the published minimum price fixed by the government. The auction takes place in three stages. The duration of each stage is determined by the burning of a short candle which usually takes 3-5 minutes. Those who increase their bid during the first two stages may proceed to the "last candle," when the right to operate the lot for two years goes to the highest bidder. Dai ownership is divided among ethnic lines as follows: 46% Khmer, 50% Cham (Muslim) and 4% Vietnamese.

In the 1995 auction, dai units varied in price from ca. US$200 to over $5,000 for one year, reflecting differences in profitability. Despite a bumper catch in 1994-95, the average price ($1,921) was ca. 4% less than in 1993, and 10 dai lots were not auctioned, due to lack of bidders.

Usually, fresh fish are sold on the riverbank near the dai unit to traders who take them mainly to Phnom Penh city markets. More valuable fish (usually the bigger fish) are often kept alive in cages below the working platform of the dai. Quantities vary from 6 to 20 t, but fishers complain that numbers are decreasing. These fish are sold from March through September, when fish prices are higher than in the main fishing season and comprise such species as: Pruol, Krom, Po, Chhkok, Chhpin and Pra (see Table 1). Fresh fish consumption is important among people living close to fish production areas and markets, but in rural areas far from natural water bodies or markets, processed fish is more important. At the height of the season, when fish catches are very large, most are processed into fish paste (*prahoc*), fermented fish (*phaok*), sweet fish (*mam*), smoked fish and fish sauce. Surplus fish are dried for pig feed or fertilizer. Species used for fish paste, etc. are the small fish like riel, sluk russey, kros, linh, kaek, kralang and kanh chruk (see Table 1).

Since the government prohibited the export of this kind of fish to Vietnam in 1990 (Touch 1993), apparently a surplus has been created, leading to lower prices (down to $0.02·kg^{-1}) and a decrease in the number of dais.

Sampling Method and Results

All dai units in Phnom Penh and Kandal (73 dais in 15 rows) were divided into three minor strata (rows 1-5, 6-10 and 11-15). Sampling was conducted randomly with an average frequency of 2 d per month. Stratification in time was also applied: a peak period of 4-6 d before full moon and a low period consisting of the rest of the month. Catch per lift was estimated, as well as the

Table 1. Estimated catch by species of the 1994-95 bagnet/dai fisheries ranked in order of importance. For comparison the species abundance in 1962-63 (in%) and 1938-39 (relative abundance) is presented.[1]

Species[2]	Khmer name	Estimated catch (t) Dec 94	Jan 95	Feb 95	Total	% of Total catch	1962-63 % catch	1938-39 rel. abundance
Henicorhynchus spp.	Riel	55	6,834	5,543	12,432	67.52	25.4	++++++
Paralaubuca typus	Sluk russey	31	1,562	866	2,460	13.36	0.3	+++++
Dangila spp./*Osteochilus hasselti*	Khnong veng/Kros	42	543	394	979	5.32	-	+++++
Thynnichthys thynnoides	Linh	3	479	33	515	2.80	14.9	+++++
Morulius chrysophekadion	Kaek	17	420	34	471	2.56	2.0	++++
Cirrhinus microlepis	Pruol/Kralang	4	143	251	398	2.16	18.6	++++
Botia spp.	Kanh chruk	4	171	94	270	1.47	0.2	+
Cyclocheilichthys enoplos	Chhkok	38	70	84	192	1.04	1.7	+++
Clupeoides/Clupeichthys spp.	Bandaulampou	1	11	77	88	0.48	1.6	+
Micronema apogon	Kes	1	82		83	0.45	0.3	++
Pang. siamensis/spp.	Chhweat	1	55		56	0.31	1.5	+++++
Pangasius concophilus	Pra ke	3	30		33	0.18	0.0	++
Amblyrhynchichthys truncatus	Kambot chramos	10	16	4	30	0.16	0.7	+
Osteochilus melanopleura	Krom	18	7		26	0.14	3.2	++++
Pang. hypophthalmus/spp.	Pra	5	17		22	0.12	0.4	++
Mystus nemurus	Chhlang	0		11	12	0.06	0.0	++
Pangasius larnaudiei	Po	10			10	0.06	0.4	++
Barbodes altus	Kahe	1	9		10	0.06	7.5	++++
Puntioplites proctozysron	Chrakeng	5	1		6	0.03	3.2	+++
Macrochirichthys macrochirus	Dang kteng	5			5	0.03	0.1	+++++
Cosmochilus harmandi	Kampoulbai	4			4	0.02	0.7	+
Parambassis wolffi	Kantrang preng	1	3		3	0.02	2.6	++++
Belodontichthys dinema	Khlang hai	3			3	0.02	0.5	++++
Coilia spp.	Chanluonh mean		2		2	0.01	2.8	+
Barbodes gonionotus	Chhpin	1			1	0.01	0.7	+
Osteochilus schlegeli	Lolok sor	1			1	0.01	-	+
Probarbus jullieni	Trasork	1			1	0.00	0.0	+
Tenualosa thibaudeaui	Kbork	1			1	0.00	7.7	++++
Systomus orphoides	Ampil tum	0			0	0.00	1.0	+
Cyclocheilichthys apogon/spp.	Sraka kdam	0			0	0.00	0.0	+++
Leptobarbus hoevenii	Pralung	0			0	0.00	0.7	+++
Other species		13	245	37	295	1.60	1.3	
Total		279	10,701	7,429	18,410	100.00	100.00	

[1]Data adapted from Fily and d'Aubenton (1965) and Chevey and Le Poulain (1940).
[2]Scientific nomenclature follows Rainboth (in press).

number of lifts per 24 h. The total catch of a lift was sampled for species composition at low periods, while subsampling was necessary at peak periods. Length frequency samples of selected species were also taken.

ARTFISH, computer software for the estimation of fish catches and effort (Stamatopoulos 1994), was used to estimate catch by species of the 73 dai units in December 1994, January and February 1995. The overall catch was estimated to be 18,410 t. The breakdown by species and months is given in Table 1.

Differences in day and night catches per lift apparently are insignificant. However, the number of lifts at night can be less than during the day, and thus should be accurately assessed on sampling days, as variations in effort have a greater impact in the catch estimation process than variations in the catch itself.

Discussion

Catches of individual dai units were found to vary greatly within rows and between rows. This was also reported by Fily and d'Aubenton (1965) who suggested a link between high catches and optimum water current velocities. Although reliable catch data of individual dai units are not available, it is believed that the price for which a dai is auctioned reflects its perceived productivity. In the future therefore, dai units will have to be stratified (for random sampling) into two strata: those with an auctioned price above and below the Riel equivalent of US$3000. Stratification by group of rows, as applied in 1994-95, will not be continued.

Fish catches at the peak period are extremely high and sampling must be more intensive than at the low period, as the level of the monthly catch is determined in this short interval. Therefore, the stratification in time (peak period/low period) will have to be maintained in future sampling programs.

It appears from Table 2 that our estimates are much higher than those provided by the DOF, but close to the estimated catch for the peak year of 1985-86 recorded by Nguyen and Nguyen (1991). According to the dai operators, catches in 1994-95 were higher than experienced for many years. This was attributed to higher water levels than usual. DOF statistics show that the 1994-95 catch was among the highest with 1985-86 and 1990-91. Mr. Ian Baird (pers. comm.) reported from southern Laos (Khone Falls area) the presence of much

Table 2. Past and present estimates of total catch, number of dai units and catch per dai.

Season	Total catch (t)	No. of dais	Catch/dai (t)	Reference
1938-39	(13,568)	106	128	Chevey and Le Poulain (1940)
1962-63	(2,135)	61	35	Fily and d'Aubenton (1965)
1981-93	5,000-12,839	97-75	-	DOF statistics
1983-88	7,413-18,026	86	86-209	Nguyen and Nguyen (1991)
1994-95	10,755	73	161	DOF (pers. comm.) (1995)
1994-95	18,410	73	252	Project estimates (1995)
1995-96		63		Auction results (1995)

larger numbers of small migratory fish species (especially juvenile *Cirrhinus microlepis*, Kralang) in the catches during January and February 1995, a phenomenon that had not occurred for several years. Apparently, only in years of high productivity do these species migrate in significant numbers farther up river; suggesting a density-related effect.

For comparison, the species composition for 1962-63 (Fily and d'Aubenton 1965) and for 1938-39 (Chevey and Le Poulain 1940) is also shown in Table 1. It appears that the share of the small prolific opportunistic species is much higher than suggested by Fily and d'Aubenton's data. Probably this is largely due to under-estimation of this group by Fily and d'Aubenton, because of their relatively low value and predominant use for fish paste or fertilizer. Species, such as *Dangila* spp./ *Osteochilus hasselti* (Khnong veng/Kros) and *Paralaubuca typus* (sluk russey) forming, respectively, 5.3 and 13.4% of the present catches, were respectively, not or hardly (0.3%) reported in 1962-63. It is unlikely, however, that they were absent from the catches in those days given their high abundance in 1938-39. The Mekong Secretariat (1992) also commented on these discrepancies in the Fily and d'Aubenton (1965) data. It is interesting to note the absence of *Catlocarpio siamensis* (kolreang/giant barb) and *Puntioplites bulu* (kanchrea) from the present catches, while in 1938-39 and 1962-63, specimens were still seen regularly. Also *Leptobarbus hoevenii* (pralung/mad barb) *Barbodes altus* (Kahe) and the endemic *Tenualosa thibaudeaui* (kbork/Mekong River shad) have become scarce, when compared to 1962-63 and 1938-39. Roberts (1993) attributes the decline of shad at the Khone Falls to increases in fishing effort.

References

Chevey, P. and F. Le Poulain. 1940. La Peche dans les eaux douces du Cambodge. Travaux de l'Institut Oceanographique de l'Indochine. 5e Memoire, Gouvernement Generale de l'Indochine. Saigon. 241 pp.

FAO. 1994. Cambodia. Rehabilitation and development needs of the fishery sector. FAO Fisheries Circular 873. Food and Agriculture Organization, Rome. 89 pp.

Fily, M. and F. d'Aubenton. 1965. Cambodia. Report on fisheries technology in the Great Lake and the Tonle Sap, 1962-1963. National Museum of Natural History, Paris. 509 pp.

Mekong Secretariat. 1992. Fisheries in the Lower Mekong Basin. Annex 5: Review of the fishery sector in Cambodia. Mekong Secretariat, Bangkok. 58 pp.

Mekong Secretariat. 1993. Development plan for Tonle Sap and Chakdomuk. Phase I. Report by ORSTOM and BCEOM for the Mekong Secretariat, Bangkok.

Nguyen, X.T. and V.H. Nguyen. 1991. Investigation of the freshwater fish productivity of Cambodia (1986-88) Fishery Service of Vietnam, Hanoi. 126 pp. (In Vietnamese.)

Rainboth, W. Fieldguide to the fishes of the Cambodian Mekong River. FAO Species Identification Sheets for Fishery Purposes. Food and Agriculture Organization, Rome. (In press.)

Roberts, T.R. 1993. Artisanal fisheries and fish ecology below the great waterfalls of the Mekong River in southern Laos. Natural History Bulletin of the Siam Society 41:31-62.

Stamatopoulos, C. 1994. A microcomputer system for the statistical monitoring of artisanal fisheries. Version 1. Food and Agriculture Organization, Rome. 35 pp.

Touch, S.T. 1993. Fish supply and demand in rural Svay Rieng province, Cambodia. Asian Institute of Technology, Bangkok. 114 pp. M.S. thesis.

Manuscript received 16 December 1995; accepted 28 December 1995.