東南アジア諸島部の在来型漁船

K. W. A. Masengi*・柴田 恵 司**

Indigenous Fishing Canoes of Southeast Asian Islands

Kawilarang W. A. MASENGI and Keishi SHIBATA

要 約

東南アジア諸島部の在来型漁船（アウトリガー・カヌー）は、その両舷にアウトリガー浮木を備え、この地域における漁業の主力である。しかし、近年における推進機関の導入、あるいは、造船用材となる森林資源の減少などに伴って、その船型が変わりつつある。

そこで本研究では、これらカヌーの現状、特に船型を正確に記録保存すると同時に、周辺地域における様々な小型漁船を、主要寸法と線図から求めた満載時船型諸元によって比較することにある。このため、縮尺率1/4の木製パントグラフによって船体線図作成のための直接計測をスラウエッソンで、カヌー、20隻、西マレーシア東岸で、アウトリガー無しの在来型構造船6隻、さらに、沖縄県下のサバニ、6隻を計測した。そのほか、パプア・ニュー・ギニア（PNG）と、フィリッピンのカヌー、和船のほか、日本の近代的な小型漁船の資料を併せた合計52隻を比較検討し、東南アジア諸島部のカヌーの船型の特長を明らかにしようとした。

これらのカヌーは、丸木作りの船底構造部の上に狭い板を積み重ねた準構造船が主で、丸木船も含まれる。

その船体は、満載喫水における $L/B=12$ と極めてスリムであり、その幅は、地域平均で、43～53センチと著しく狭く、その横復元力は、全長より短い竹のアウトリガーで支えられている。また、船体はほとんど船首尾同型であるため、浮面心、浮心の前後位置は、ほぼ船体の中央にある。これらが、カヌーの特長である。なお、フィリッピンとスラウエッソンのカヌーとは船型的に近い関係にあるが、PNGのカヌーを除く、他のいずれの船とも、明らかに異なっている。

1. Introduction

Indigenous fishing canoes of the Southeast Asian Islands generally have an outrigger on both sides and these small canoes are the main source of coastal fishing around the islands. However, the canoe hull construction is changing due to the recent introduction of modern fishing technologies. This includes motoriation and the use of new fishing gear materials. The purpose of this study is to record the current state of the canoes and to consider future trends in the type of coastal fishing canoes in this area.

Traditional type of fishing canoes in the Southeast Asian Islands generally consist of a very slim and shallow hull both ended with an outrigger float on both sides held by two wooden booms. As reported by C. Nooteboom¹⁾, A. Haddon²⁾, J. Hornell³⁾, A. Horridge⁴⁾, A. Masengi and K. Shibata⁵⁾, G. Aguilar⁶⁾, many local varieties of fixing methods for the floats and booms are found by site. This account shows that the outrigger systems are the weak point of the canoes as reported previously by Matsuoka⁷⁾.

* Member, Graduate School of Marine Science and Engineering, Nagasaki University 1-14, Bunkyo-Machi, Nagasaki Shi 852, JAPAN

** Member, Faculty of Fisheries, Nagasaki University 1-14, Bunkyo-Machi, Nagasaki Shi 852 JAPAN

2. Methodology

Field surveys to draw hull-lines were made on 35 coastal fishing canoes in 8 sites of the Philippines and 15 sites of Sulawesi from 1988–1989. The sites are given by black spots in Fig. 1.

Certain dimensional parts of the hull and outrigger systems of typical canoes by site were measured as shown in Fig. 2.

A series of cross sectional curves of the canoe was taken by section at 13 stations of certain interval by means of a pantograph of 1/4 scale ratio.

Several characteristic parameters were calculated from a offset table from the hull-lines and principal dimensions, Lpp, B, D and full-load draft of the canoe. The draft was determined from midship height of an outrigger above the keel. Various technical terms in this report are given in Appendix.

3. Result and considerations

3.1 Principal dimensions of outrigger canoes

The canoes have a very slim and shallow hull both ended of dugout or semi-dugout hull type, with a securing washstrake upon the dugout base.

The interrelations between Lpp and Loa are significant at 5% level and a simple regression between them is :

$$Lpp = 0.76135 \text{ Loa} + 0.86138, \quad (n=35, r=0.9159).$$

The canoes in this study are very slim with a mean Lpp/B of 11.9.

Interrelation between the Lpp and breadth, B, is shown in Fig. 3 and a regression is :

$$B = 0.05392 \text{ Lpp} + 0.17259, \quad (r=0.760189).$$

In this figure, the londe type of canoe from North Sulawesi are generally gathered around the regression line at the left lower corner of the figure. The pambuts and motors of the Philippines and pelang-motors of Sulawesi are seen only in the lower side of the line while Cavite bancas and

Fig. 1. Site map of fishing boats sampled.

Fig. 2. Various parts of canoes measured in this study.

Zamboanga basilans of the Philippines and a sampan, bolotu and semasema of Indonesia are found only in the upper side. The sakayas of Central Sulawesi have a relatively fair hull in comparison.

3.2 Outrigger system

Outrigger systems of the canoes are essential for increasing their stability. Fixing systems of outrigger floats to the outrigger booms are very different by site and can be divided roughly into two types of the system ; 1) solid systems which hold the floats with wooden booms and 2) flexible systems which absorb wave force which acts on the floats with booms located at very narrow intervals, with loose connection between the floats and boom ends and between booms and the hull top. The solid system is commonly used in Southeast Asian Islands while the flexible system is generally used in the Tropical Islands of the Pacific⁷⁾.

The length of outrigger floats, L_f , are about 67% of L_{pp} in mean. Interrelations between L_{pp} and L_f are shown in Fig. 4 and its significant regression is :

$$L_f = 0.77065 L_{pp} - 0.37669, \quad (r = 0.8801).$$

In this figure, the data spots are generally found around the line and are not really remarkable

Fig. 3. Interrelation between L_{pp} and B of various outrigger canoes by type in Sulawesi and Philippines from 1985—1989.

Symbols $\times$: baloto ; $\diamond$: banca ; * : motor ; $\odot$: pambut ; $\square$: B. banca ; ∇ : jolouan ; $\blacktriangledown$: londe ; $\blacksquare$: pelang ; $\blacktriangleright$: pelang-motor ; $\bullet$: sakaya ; $\star$: sampan and $\blacklozenge$: bolotu.

Fig. 4. Interrelation between L_{pp} and Length of outrigger float by type in Sulawesi and the Philippines. Symbols are all the same as in Fig. 3.

Fig. 5. Interrelation between L_{pp} and length of outrigger booms by type in Sulawesi and the Philippines. Symbols are all the same as in Fig. 3.

Fig. 6. Interrelation between L_{pp} and interval distance of outrigger booms by type in Indonesia and the Philippines. Symbols are all the same as in Fig. 3.

Fig. 7. Interrelation between Lpp and displacement of the canoes by type in Indonesia and the Philippines. Symbols are all the same as in Fig. 3.

Fig. 8. Interrelation between Lpp and horizontal distance of the center of flotation from midship of the canoes in Indonesia and the Philippines. Symbols are all the same as in Fig. 3.

Fig. 9. Interrelation between vertical prismatic coefficient and ratio of vertical center of buoyancy and draft of the canoes by type in Indonesia and the Philippines, and modern fishing boats⁹⁾. Symbols are all the same as in Fig. 3.

Fig. 10. Interrelation between Cb and Cvp of the canoes by type in Indonesia and the Philippines. Symbols are all the same as in Fig. 3.

in account by type.

The length of boom which holds by the floats, BB, is about 54% of Lpp in mean and is generally longer on the Sulawesi canoes than on the Philippine canoes.

The interrelation between Lpp and BB is shown in Fig. 5 and the regression is :

$$BB = 0.5309 Lpp - 0.00407, \quad (r = 0.818033).$$

In this figure, local varieties by type are not significant. However, the BB value of the balotos hardly changes with their Lpp.

On average, Intv, longitudinal interval between fore and aft booms is 46% of Lpp.

The interrelation between Lpp and Intv is shown in Fig. 6 and its regression is :

$$Intv = 0.64135 Lpp - 0.85022, \quad (r = 0.850840).$$

In this figure, distinct differences between Philippine and Sulawesi canoes were not found. Among them, the Intv of the motors and pelang motors are slightly shorter than that of other types. The reason for this is the wave force which acts on the outrigger system, when the canoes

Table 1. Mean vectors of principal dimensions and hydrostatic parameters at full load condition of various fishing boats.

Category		Outrigger canoe			Plank	Sabani	Wasen		FRP	steel
Area		Philip- pines ⁶⁾	Sula- wesi	PNG ⁷⁾ *	Malay- sia	Oki- nawa	Yama- gata ¹¹⁾	old ¹²⁾	Japan ⁹⁾	
Year		1988	1986- 1989	1987	1988- 1989	1976 & 1989	1980	1725- 1955	1980- 1985	1979- 1985
Item	N	15	20	7	6	11	15	23	16	16
Lpp	m	6.15	5.16	5.70	5.71	6.71	6.31	9.30	20.14	24.45
B	m	0.53	0.44	0.43	1.61	1.18	1.56	2.13	4.56	5.47
D	m	0.46	0.46	0.42	0.62	0.55	0.50	0.94	1.74	2.22
d	m	0.29	0.30	0.26	0.47	0.33	0.33	0.57	1.27	1.81
Δ	ton	1.00	0.35	0.28	1.54	1.20	1.94	5.45	87.20	170.12
Cb		0.54	0.45	0.64	0.39	0.40	0.51	0.42	0.66	0.68
Cp		0.70	0.64	0.77	0.60	0.58	0.67	0.65	0.74	0.75
Cw		0.67	0.64	0.85	0.58	0.58	0.68	0.67	0.93	0.97
Cm		0.76	0.70	0.75	0.65	0.64	0.76	0.65	0.87	0.91
L/B		11.93	11.84	13.22	3.67	5.88	4.04	4.37	4.42	4.47
L/D		13.65	11.25	14.24	9.28	12.86	12.62	9.90	11.57	11.01
B/D		1.16	0.99	1.07	2.62	2.22	3.12	2.27	2.62	2.46
KB/d		0.55	0.62	--	0.50	0.58	0.76	0.68	0.59	0.60
HB/L(%)		-0.00	-0.02	--	0.57	0.41	5.94	1.03	5.23	2.50
KMT/B		0.49	0.51	--	0.38	0.38	0.48	0.50	0.53	0.51

Remarks: Parameters of the canoes are only on hull body, excluding outriggers.
Asterisked is single outrigger canoe.

run at high speed in rough sea.

3.3 Hydrostatic parameters

The hydrostatic parameters of the canoes are considered at full-load condition. Coefficients and constants of significant regressions of various parameters for Lpp are shown as follows:

3.3.1 Lpp vs W

Interrelations between Lpp and displacement, W, are shown in Fig. 7. As shown in this figure, W varies with the 3rd power of Lpp. A regression between them is:

$$W = 0.00281 Lpp^3 + 0.00332, \quad (r = 0.95338).$$

The Philippine canoes are scattered on the upper side of the regression curve while Sulawesi canoes, are on the lower side.

3.3.2 Lpp vs HF

Interrelation between Lpp and horizontal distance of the center of flotation from midship, HF, is shown in Fig. 8. In this figure, a horizontal line shown HF=0.

As shown in this figure, Hf is very small, compared with HF of modern vessels and even takes a negative value for about 50% of the total number of canoes, because many of them have a both ended hull. This account of HF is similar to that of HB, horizontal distance of the center of buoyancy from midship.

The correlation coefficient between them is very low at 0.44 and significant at a tolerance level

of 1%. This account shows that the canoes have distinctly local varieties in hull construction by village.

3.3.3 Cvp vs KB/d

Interrelations between Cvp and KB/d are shown in Fig. 9. In this figure, a solid line of a regression calculated from data and a chain line by Morrish's equations on modern vessels agreed each other well⁸⁾.

The Philippine canoes, excepting each one of the bancas and Palawan pambuts are plotted on the lower side of Morrish's line while canoes of 80% for the Sulawesi total, are on the upper side.

The regression is :

$$KB/d = -0.47954 Cvp - 0.9392, \quad (r = -0.89282)$$

3.3.4 Cb vs Cvp

Interrelations between Cb and Cvp are shown in Fig. 10. In this figure, a solid line is a regression of the canoes and a chain line, modern fishing boats and cargo vessels⁹⁾. These lines differ somewhat from each other.

These regressions are :

on canoes, $Cvp = 1.15296 Cb + 0.1897$ ($r = 0.69325$), on cargo vessels, $Cvp = 0.47245 Cb + 0.5281$ ($r = 0.91902$, $n = 22$). As shown in this figure, the Philippine canoes generally have larger values of Cvp and also of Cb than them in Sulawesi.

4. Discussions and conclusions

Some comparative considerations on principal dimensions, ratios and hydrostatic parameters were made among the canoes, "Wasen", coastal fishing boats of Japanese type and modern fishing boats of steel and FRP (Fiber Reinforced Plastics) as shown in Table 1. In this table, year sampled or design date and sample size, N is given.

All of canoes from Papua New Guinea, have an outrigger only on one side while the others have outriggers on both sides. The whaling boats are mainly the wasens in use for whaling in Edo Era and several small wasens of average size for the 20th Century. The modern fishing boats of steel are from 44—69 G/T and of FRP from 16—65 G/T⁹⁾.

The outriggers are generally comparable in principal dimensions, but the PNG outriggers are however, generally larger in fineness coefficients, L/B and L/D than the other double outriggers.

Table 2. Correlation coefficients and simple regressions between B and Lpp of various fishing boats. $B = a Lpp + b$.

Fishing boat	n	r	a	b	F	α (%)
Outrigger						
Sulawesi	20	0.45005	0.02516	0.31113	4.57	5.0
Philippine	15	0.82922	0.07386	0.07495	28.61	0.5
P.N.G.	7	0.93920	0.04376	0.17636	37.41	0.5
Sabani						
Okinawa	11	0.76925	0.18810	-0.08503	13.04	0.5
Wasen						
Yamagata	15	0.93863	0.13222	0.72590	96.26	0.5
old	23	0.86568	0.20173	0.25889	62.80	0.5
modern boat						
steel	15	0.62643	0.15049	1.78744	8.39	2.5
FRP	16	0.59009	0.09464	2.65412	7.48	2.5

Only the double outriggers have very small, negative values in location of the center of buoyancy, HB. This can be accounted for by the fact that they have a hull with pointed both ends.

Those outriggers have a very narrow hull, compared with the wasens and modern fishing boats as shown by the L/B value and a rather shallow hull relatively to L than the others.

KB/d and KMT/B hardly differs among the outriggers and the modern fishing boats.

4.1 Lpp vs B

Simple regression coefficients, a , and constants, b , of various kinds of fishing boats are shown with correlation coefficients, r , in Table 2.

In this table, alpha is the tolerance level in percent obtained from an F-test.

Regression lines of Lpp and B by type of the boat are shown in Fig. 11. The lengths of these lines shown in the respective ranges of Lpp.

In this figure, the outriggers from three areas are gathered in the lower and left corner while the others, are in the upper side. The above two groups quietly differ from each other. The Lpp values hardly vary with B on the outrigger canoes while varying greatly with B on the upper side group.

4.2 Fineness coefficients

Cb are the largest in the modern fishing boats throughout 7 kinds of the boats. The Cb is the largest at 0.64 on PNG canoes among the outriggers, while the smallest is 0.45 for the Sulawesi canoes. This account is rather same on the wasens with values from 0.42—0.51. Cp from 0.64—0.77 are the biggest on PNG canoes and the smallest on Sulawesi canoes. However these differences of Cp are generally small.

Cw are ranged from 0.64—0.97. The largest values are for modern fishing boats and the smallest, for the Sulawesi canoes. Among the canoes, the PNG canoes are the biggest at 0.85.

Cm ranges from 0.65—0.91. The largest are for modern fishing boats, while the smallest are for the old wasens. The canoes resemble well on Cm to the wasens from Yamagata Prefecture.

4.3 Ratios of principal dimensions

As shown in Table 1, L/B ranges from 4.04—13.36. The ratio for the canoes is about two times that of the wasens. The ratios for the wasens is very similar to that of the modern fishing boats.

The B/D ratio is around 1.0 for the canoes and is distinctly smaller than the B/D of other boats including modern fishing boats with values of 2.22 for the sabanis in Okinawa to 3.1 for the wasen in Yamagata.

Interrelations between L/B and B/D of the fishing boats in Table 1 are shown in Fig. 12. In this figure, the ordinates are L/B and B/D. The canoes are generally gathered in the lower right part of the figure and the PNG canoes are plotted only at values of L/B of 12 or more

Fig. 11. Interrelation between Lpp and B of various canoes and fishing crafts of Indonesia, the Philippines, Papua New Guinea and Japan from 1976—1989.

Source : ● : Sulawesi ; ◎ : Philippines canoes⁶⁾ ; ⊙ : Papua New Guinea⁷⁾ ; ◆ : sabani¹⁰⁾ ; + : Yamagata¹¹⁾, and × : old wasen¹²⁾.

Fig. 12. Interrelation between L/B and L/D of various canoes and fishing crafts of Malaysia, Indonesia, the Philippines, Papua New Guinea and Japan.

while the other crafts excluding some sabanis, are found only in the left upper corner with L/B values of 6 or more and ratios of B/D of 1.7 or more. The Sabanis are plotted at the right edge of the later group and some of them, at the intermediate part between the above two groups.

5. Future problems of the canoes

Construction of the canoes is going to change due to the recent introduction of the marine engine. With regards to this problem, construction strengths of the hulls should be increased against machinery vibrations. This is because water tight construction of the canoes built by traditional techniques using with wooden pegs are weak against such vibrations.

The outrigger acts strongly to increase canoe stability. Otherwise, it has some inconveniences; 1) the maximum draft of the canoe is limited when the floats are submerged and 2) the floats are inconvenient when alongside a pier of fishing with a cast net. We would like to introduce planked crafts, such as the Sabani of Okinawa, instead of outrigger canoes to overcome the above shortcomings of the outrigger.

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Appendix : Nomenclature

G/T	: Gross registered tonnage
L	: Length overall
Lpp	: Length between perpendiculars
B	: Maximum breadth
D	: Maximum depth the top of ride boards to the bottom surface of the keel
d	: Maximum draft determined from the height of outrigger float amidship
Lf	: Length of outrigger float
BB	: Transverse distance amidship from an outrigger to another one (double rigger) or opposite side of the hull (single rigger)
Intv	: Longitudinal interval distance between fore and aft outrigger booms
W	: Displacement
HF	: Longitudinal distance of the center of flotation from midship
HB	: Longitudinal distance of the center of buoyancy from midship
KB	: Height of the center of buoyancy above the bottom keel
KMT	: Height of the transverse metacenter above the keel
Cb	: Block coefficient
Cp	: Prismatic coefficient
Cm	: Midship coefficient
Cvp	: Vertical prismatic coefficient

質 疑 応 答

本田啓之輔(神戸商船大学) : Outrigger の長短の差, あるいは両舷にあるものと片舷だけにつけられたものとの相違は, 地域的な漁法によるものですか, あるいは強度の構造的な理由によるものですか。

アレックス・マセンギ : Outrigger system の様式は, 地域ごとと言って良いくらい, 様々な地方型が認められます。この多様性は反面, この system がこの種のカヌーの weak point であることを示すと考えます。

一般に, 両舷に outrigger を持つ, double-rigger は主に, 東南アジア諸島部に分布していますが, 片舷のみの single-rigger はその他のインド洋沿岸および, 熱帯太平洋諸島に見られます。前者の outrigger framework は一般に, いわば剛体構造で, 丸竹の浮体が, 広い前後間隔で設けた支持枠に, しっかりと固定されています。これに反して, 太平洋諸島部のは, 短い浮体(木製)を短い前後間隔の支持枠に, 間接的に連絡してあります。即ち, 波浪が比較的大きなこの水域のカヌーでは, この浮体と船体の間に生ずるモーメントをこのような柔軟構造で吸収しようとしています。また, マカッサルの漁村では, 投網を使うようになってから, single-rigger に変わりました。