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Morphological Comparison between Chinese Ayu and Japanese Ayu and Establishment of *Plecoglossus altivelis chinensis* Wu & Shan subsp. nov.

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Abstract The countable characters of Qingdao, Zhejiang, Liaoning and Japanese Ayu are compared. There are no substantial different characters among the former three Ayu, so the comprehensive values of them are taken as representative of Chinese Ayu, which is in turn compared with Japanese Ayu (*Plecoglossus altivelis altivelis* and *Plecoglossus altivelis ryukyuensis*). By the coefficient of difference test, 3 and 4 characters are found to be beyond the subspecies level between Chinese Ayu and nominate subspecies (*Plecoglossus altivelis altivelis*) and between Chinese Ayu (*Plecoglossus altivelis chinensis*) and Ryukyus subspecies (*Plecoglossus altivelis ryukyuensis*), respectively, which shows that they belong to different subspecies. The China mainland Ayu is a new subspecies, *Plecoglossus altivelis chinensis* Wu & Shan, the establishment of which and its forming causes are discussed.

Key words morphological comparison; *Plecoglossus altivelis chinensis* Wu & Shan; geographic isolation; population; subspecies differentiation

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Ayu (*Plecoglossus altivelis*) belongs to Osmeriformes, Osmeridae, *Plecoglossus*. It is small-sized, one-year living species with high economic value. It can be found in China, Japan, the Peninsula of Korea, and the north of Vietnam. Nishida (1988) classified Japanese native Ayu into two subspecies: nominate subspecies (*Plecoglossus altivelis altivelis*) mainly distributed in the mainland of Japan, the peninsula of Korea, Taiwan and China mainland; Ryukyus subspecies (*Plecoglossus altivelis ryukyuensis*) only distributed in Amami-oshima Island and Okinawa Island. In China, Ayu is distributed mainly in the provinces of Liaoning, Hebei, Shandong, Zhejiang, Fujian, Guangxi and Taiwan (Mori, 1927; Reeves, 1927; Wu, 1931, 1934; Wang, 1933; Nichols, 1943; Zhang *et al.*, 1955; Zhu *et al.*, 1962; Zheng, 1981; 'Fishes of Fujian Province' editorial subcommittee, 1984; Shen, 1994). But for the population differences of different areas only Shen (1994) and Li *et al*. (1995) have reported the differences between the native Ayu population and that of Japan. The former pointed out that the lateral line scales (longitudinal scales in fact) of Taiwan Ayu are about 10 less than that of Japan, 2 rows more in scales above lateral line, 2 more in the number of pectoral fin rays (anal fin ray was mistaken for pectoral fin ray by Shen; The latter pointed out outstanding morphological differences exist among Fuxi Ayu of Zhejiang, China and Kyoto, Okinawa and Biwa-ko Ayu of Japan, but not make a comprehensive comparison among the other areas Ayu of China and the two Japan Ayu subspecies (*P. altivelis altivelis* and *P. altivelis ryukyuensis*), so as not to further research into the intraspecies differentiation of Ayu.

At present, Ayu has already been listed in the 'red list of fishes' in China mainland and protected and managed strictly, so it is impossible to gain wild specimens. In order to study the intraspecies differentiation of Ayu, the authors have resorted to identifying the Ayu specimens in Ocean University of China, which were caught from Qingdao of Shandong, Haicheng of Liaoning and Ninghai of Zhejiang in 1979, consider the comprehensively identified value of Ayu of these three areas as representative of Chinese Ayu, and make use of the relevant reports of previous authors.

1 Materials and Methods

Specimens were caught by Mr. Du Z.Y. of Ocean University of China in 1979, including the 62 Qingdao Ayu specimens (one specimen surface damaged), 30 Zhejiang Ayu specimens, and 40 Liaoning Ayu

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specimens. Ryukyus subspecies was cited from Nishida (1988). Nine countable characters were compared among them. To determine the countable characters, anatomical lens were used, and variations were tested by coefficient of difference.

2 Comparison of Countable Characters among Ayu of Qingdao, Zhejiang, Liaoning of China, Chinese Ayu and Japanese Ayu

Longitudinal scales, scales above and below lateral line, number of gillrakers, anal fin rays and pectoral fin rays, comb-like teeth on upper and lower jaws, and vertebrae number of Qingdao, Zhejiang, Liaoning Ayu of China and Japanese Ayu are arranged in Table 1. From Table 1 we see that longitudinal scale numbers of Qingdao, Zhejiang, Liaoning Ayu of China are mainly 135–164, mode being 145–149, while Ryukyus subspecies, 110 – 134, nominate subspecies, 120 – 179, with its mode 140–144; the mode of scale above lateral line of Qingdao, Zhejiang, Liaoning Ayu of China is 20; Ryukyus subspecies, 16, nominate subspecies, 18; the modes of scale below lateral line of Qingdao, Zhejiang, Liaoning Ayu of China are 14, Ryukyus subspecies, 10, nominate subspecies, 12; the modes of anal fin ray of Qingdao, Zhejiang, Liaoning Ayu of China are 17, Ryukyus subspecies, 16, nomi-

Table 1 The frequency of distribution of countable characters among Ayu of Qingdao, Zhejiang, Liaoning of China and Japanese Ayu

CPA	Longitudinal scales; CHA															
	100 | 104	105 | 109	110 | 114	115 | 119	120 | 124	125 | 129	130 | 134	135 | 139	140 | 144	145 | 149	150 | 154	155 | 159	160 | 164	165 | 169	170 | 174	175 | 179
QD	0	0	0	0	0	0	1	3	9	16	13	10	4	3	2	0
ZJ	0	0	0	0	0	0	1	1	5	5	6	9	2	1	0	0
LN	0	0	0	0	0	0	1	4	4	14	7	5	4	1	0	0
CH	0	0	0	0	0	0	3	8	18	35	26	24	10	5	2	0
P.a.r	2	0	14	12	19	7	1	0	0	0	0	0	0	0	0	0
P.a.a	0	0	0	0	2	9	11	18	30	21	19	8	11	8	3	2

CPA	Scales above lateral line; CHA												Scales below lateral line; CHA									
	14	15	16	17	18	19	20	21	22	23	24	25	8	9	10	11	12	13	14	15	16	17
QD	0	0	0	0	11	16	14	11	5	2	2	1	0	0	0	0	0	10	27	16	7	1
ZJ	0	0	0	0	0	2	12	7	6	2	1	0	0	0	0	0	0	3	13	8	6	0
LN	0	0	0	0	3	10	21	5	0	1	0	0	0	0	0	0	1	7	18	7	5	2
CH	0	0	0	0	14	28	47	23	11	5	3	1	0	0	0	0	1	20	58	31	18	3
P.a.r	16	13	21	6	0	0	0	0	0	0	0	0	2	14	35	5	5	0	0	0	0	0
P.a.a	0	0	1	22	38	27	22	13	18	8	0	1	0	0	6	25	51	35	22	7	3	1

CPA	Number of gillrakers; CHA																		
	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49
QD	1	1	3	3	4	10	12	5	8	6	2	3	1	0	0	2	0	0	0
ZJ	0	0	0	2	4	3	5	2	3	2	5	1	2	0	1	0	0	0	0
LN	0	0	3	3	6	3	5	3	4	1	5	4	2	1	0	0	0	0	0
CH	1	1	6	8	14	16	22	10	15	9	12	8	5	1	1	2	0	0	0
P.a.r	0	2	12	11	9	8	8	5	1	0	0	0	0	0	0	0	0	0	0
P.a.a	0	0	0	0	1	3	7	6	9	25	31	29	20	9	3	2	1	0	0

CPA	Anal fin rays; CHA								Pectoral fin rays; CHA					Comb-like teeth on upper jaw; CHA						
	13	14	15	16	17	18	19	20	11	12	13	14	15	11	12	13	14	15	16	17
QD	0	0	0	6	25	30	1	0	0	2	48	11	1	1	30	18	4	0	0	0
ZJ	0	0	0	2	11	16	1	0	0	4	24	2	0	0	12	16	2	0	0	0
LN	0	0	9	22	6	2	0	1	0	4	27	9	0	1	20	15	3	1	0	0
CH	0	0	9	30	42	38	2	1	0	10	99	22	1	2	63	50	9	1	0	0
P.a.r	0	1	6	31	13	4	0	0	1	41	14	0	0	0	3	36	16	1	0	0
P.a.a	1	34	86	23	4	0	0	0	0	1	25	91	33	0	11	36	83	19	1	0

CPA	Comb-like teeth on lower jaw; CHA							Veterbrae number; CHA										
	10	11	12	13	14	15	16	54	55	56	57	58	59	60	61	62	63
QD	2	35	17	0	1	0	0	0	1	5	2	2	0	0	0	0	0
ZJ	0	14	14	1	1	0	0	2	2	4	1	1	0	0	0	0	0
LN	0	26	14	0	0	0	0	0	2	4	1	3	0	0	0	0	0
CH	2	75	45	1	2	0	0	2	5	13	4	6	0	0	0	0	0
P.a.r	0	1	32	23	0	0	0	0	0	0	0	3	17	30	5	0	0
P.a.a	0	0	5	42	86	14	3	0	0	0	0	0	0	9	68	61	6

Notes: QD: Qingdao; ZJ: Zhejiang; LN: Liaoning; CH: China; CHA: countable character; CPA: compared areas; P.a.r: *Plecoglossus altivelis ryukyuensis*; P.a.a: *Plecoglossus altivelis altivelis*.

nate subspecies, 15; The modes of pectoral fin ray of Qingdao, Zhejiang, Liaoning Ayu of China are 13, Ryukyus subspecies, 12, nominate subspecies, 14; the modes of gillraker of Qingdao, Zhejiang, Liaoning Ayu of China are 37, Ryukyus subspecies, 33, nominate subspecies, 41; the modes of comb-like teeth on upper jaw of Qingdao, Zhejiang, Liaoning Ayu of China are 12, Ryukyus subspecies, 13, nominate subspecies was 14; the modes of comb-like teeth on lower jaw of Qingdao, Zhejiang, Liaoning Ayu of China are 11, Ryukyus subspecies, 12, nominate subspecies, 14; the modes of the number of vertebrae of Qingdao, Zhejiang, Liaoning Ayu of China are 56, Ryukyus subspecies, 60, nominate subspecies, 61.

3 Comparison of Coefficient of Difference Among Qingdao, Zhejiang, Liaoning Ayu of China, and Between Chinese Ayu and Japanese Ayu

Comparison results of coefficient of difference (C. D.) for Ayu from different regions are given in Table 2. As we know, geographic isolation is the first condition for the standard of subspecies differentiation as determined by Mayr. It would be meaningless to discuss the magnitude of the coefficient of difference without consideration of this condition. The Ayu specimens that we studied completely accord with this condition. Seventy-five per cent rule of the standard of subspecies differentiation was put forward by Mayr *et al.* (1953). That is, the C. D. value beyond 1.28 between two populations showing different subspecies is completely reasonable.

The results in Table 2 show that no substantial character differences exist for the three regions of China. Between Ayu of Qingdao and Zhejiang, Qingdao and Liaoning, Zhejiang and Liaoning, there is a great similarity; But between Ayu of China and Ayu nominate subspecies (Nishida, 1988), the C. D. values of comb-like teeth on upper jaw (1.489 8), comb-like teeth on lower jaw (1.753 6), and vertebrae number (2.140 6) surpass 1.28. As for Ryukyus subspecies, the C. D. values of the four characters are also surpassing 1.28 and attain the level of subspecies, these values being 2.224 3 for longitudinal scales, 2.134 2 for scales above lateral line, 2.796 0 for scales below lateral line, and 1.300 0 for vertebrae number.

Table 2 Comparison of the coefficient of difference (C.D.) among Qingdao, Zhejiang, and Liaoning Ayu of China and between Chinese Ayu and Japanese Ayu

Character	Compared group				
	Qingdao-Zhejiang	Qingdao-Liaoning	Zhejiang-Liaoning	China-*P. a. ryukyuensis*	China-*P. a. altivelis*
LS	0.015 1	0.138 1	0.153 6	2.224 3†	0.202 9
SALL	0.307 8	0.033 9	0.511 0	2.134 2†	0.253 6
SBLL	0.080 1	0.089 2	0.029 0	2.796 0†	0.804 1
PFR	0.261 1	0.091 6	0.129 8	1.001 0	0.787 1
AFR	0.083 9	0.784 9	0.861 8	0.409 8	1.170 8
NGR	0.510 0	0.406 2	0.077 5	0.730 8	0.624 7
CTUJ	0.153 0	0.071 3	0.066 1	0.564 3	1.489 8
CTLJ	0.225 3	0.020 2	0.235 8	0.860 4	1.753 6
NV	0.359 8	0.000 0	0.329 2	1.300 0	2.140 6

Notes: †The C. D. values are larger than 1.28. (Mayr suggested a standard of subspecies separation that a character of 75% individuals of population A is different from that of 97% individuals of population B, and this makes C. D. value larger than 1.28. The C. D. value is calculated by C. D. = $(M_B - M_A)/(SD_A + SD_B)$, where A and B donate two populations, M is the mean value of a character of a population, and SD is the corresponding standard error). LS: longitudinal scales; SALL: scales above lateral line; SBLL: scales below lateral line; PFR: pectoral fin rays; AFR: anal fin rays; NGR: the number of gillraker; CTUJ: comb-like teeth on upper jaw; CTLJ: comb-like teeth on lower jaw; NV: vertebrae number.

4 Establishment of China New Subspecies of Ayu *Plecoglossus altivelis chinensis* Wu & Shan and Studies of Its Form Causes

4.1 China New Subspecies of Ayu *Plecoglossus altivelis chinensis* Wu & Shan subsp. nov.

Holotype (Fig.1): 1 specimen, No. 79803030, total length 218 mm, caught from the Baisha River, Qingdao, Shandong Province in August, 1979.

Paratypes: 131 specimens. Nos. 798001 – 798006, 798001 – 798030, 799001 – 799034, 79727001 – 79727013, 79814001 – 79814017, 79803001 – 79803029, and 79803031 – 79803032, total length 96.7–253.0 mm, standard length 80.3 –217.0 mm, caught from Qingdao of Shandong, Ninghai of Zhejiang, and Haicheng of Liaoning from July to September, 1979.

All specimens are deposited in the fish room in Ocean University of China.

Distinguished characters: As might be expected of the obvious geographic isolation, morphological differences of China new species are mainly in the comb-like teeth on the upper and lower jaws and vertebrae when compared with nominate subspecies, with C. D. values

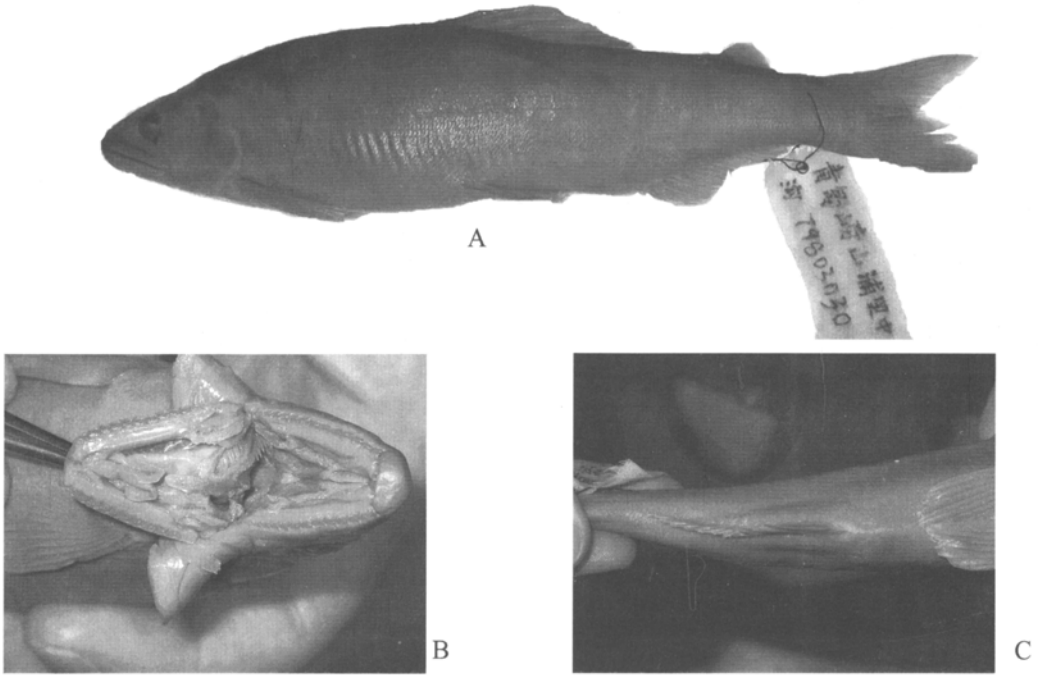

Fig.1 China new subspecies of Ayu, *Plecoglossus altivelis chinensis* Wu & Shan.
A. lateral view; B. teeth and plica membrane; C. anal scale area.

1.4898, 1.7536 and 2.1406, respectively. When compared with Ryukyus subspecies, the morphological differences are mainly in the longitudinal scales, scales above and below lateral line and vertebrae, with C.D. values 2.2243, 2.1342, 2.7960 and 1.3000, respectively. So Chinese Ayu are different from both nominate and Ryukyus subspecies.

Description: 132 specimens examined, Nos. 7981-4001 – 79814017, 79727001 – 79727013, and 7980-3001 – 79803032, collected from Qingdao; Nos. 798-001 – 798006 and 799001 – 799034, collected from Liaoning; No. 79001 – 79030, collected from Zhejiang. Total length 96.7–253.0 mm, standard length 80.3–217.0 mm; D. ii, 8–10; A. iii, 12–17; P. i, 11–14; V. i, 6–7. The gillrakers on the first outer row is 34–36, longitudinal scales are 130–172, scales above lateral line are 18–25, scales below lateral line are 12–17, head length 4.69 ± 0.2683 (4.30–5.79) times in standard length, body depth 4.84 ± 0.3547 (3.77–6.41) times, caudal peduncle length 7.82 ± 0.5982 (6.22–9.39) times, the distance between snout and vent 1.37 ± 0.0350 (1.23 – 1.45) times; head depth 1.49 ± 0.1548 (1.18 – 1.76) times in head length, the length of snout 2.90 ± 0.2024 (2.23–3.35) times, eyes diameter 4.71 ± 0.4380 (3.75–6.00) times; caudal peduncle depth 1.61 ± 0.1482 (1.25–2.00) times in caudal peduncle length; snout width 0.60 ± 0.0739 (0.44–0.80) times in the length of upper jaw; the length of gill filament 0.37 ± 0.0768 (0.24–0.63) times in the length of gillraker; the longest ray of dorsal fin 0.72 ± 0.0616 (0.56–0.97) times in the length of D-base; the length of pelvic fin rays 0.28 ± 0.0439 (0.17–0.41) times in the width of P-base. The original data are given in Table 3.

Body slender, slightly compressed; head short and small; rostrum extending down and forming rostral hook; eyes superlateral, eye diameter is shorter than the length of snout, interorbital distance wide and convex; the distance between eyes and nostril is shorter than that between nostril and snout; mouth large and long; maxilla elongated to the margin behind eyes, no supramaxilla. Both convexes in front of lower jaws form an obvious notch, and rostral hook exactly lies in the notch of lower jaws when closing mouth. A pair of large folded membrane formed by mucosa at the bottom of mouth, in the united site of lower jaw. One row of teeth, wide, compressed and mobile, arranged regularly, three teeth on each side, little teeth in palatine and tongue, but no teeth at the tip of tongue and vomer. Opercular aperture wide, extending to the margin under pupil. Branchiostegal membrane united with the front of isthmus. Gillrakers thin, long and dense. Pseudobranch developed opercular smooth. The vent relatively lies behind margin under dorsal fin, in the front of anal fin. Head without scales, body with dense and minute cycloid scales, and 3–4 rows of comparatively wide scales on two sides of anal fin and near the vent, forming a particular area of scales. Lateral line obvious and comparatively flat, to C-base.

D-origin opposite in front of V-origin. The distance between D-origin and snout is shorter than that between D-origin and C-base. A adipose fin, opposite to the latter of A-base. A-origin is nearer to C-base than to the terminal of D-base. Anal fin lies far away from behind under dorsal fin. The site of pectoral fin inferior,

Table 3 The countable and measurable characters in *Plecoglossus altivelis chinensis* subsp. nov.†

Character	Holotype	Paratypes			
	Qingdao 79803030	Qingdao 79803001 N=61	Zhejiang 79001 N=30	Liaoning 798001 N=40	China N=132
TL/mm	218	96.7-253(136.7)	130-199.5(152.3)	113.6-225(136.8)	96.7-253(144.4)
SL	187	80.3-217(116.8)	110.3-165.1(126.6)	96.3-202(117.4)	80.3-217(123.2)
BD	46.8	18.0-57.1(24.4)	22.6-38.2(26.4)	20.3-46.3(24.5)	18.0-57.1(25.9)
DSV	134	58.3-150.6(84.9)	79.1-122(95.2)	68.9-140.7(84.0)	58.3-150.6(88.9)
HL	36.8	18.4-39.8(24.9)	21.6-32.4(27.0)	21.2-38.4(25.3)	18.4-39.8(26.1)
HD	28.9	11.8-29.6(16.7)	15.4-23.5(17.9)	14.2-34.7(17.5)	11.8-34.7(17.8)
CPL	25.5	10.7-23.1(15.1)	12.4-20.8(14.5)	11.9-28(15.3)	10.7-28.0(15.8)
CPD	16.5	7.0-18.5(9.4)	8.5-14.5(10.7)	7.8-18(9.4)	7.0-18.5(9.9)
LST	14.1	5.5-13.6(8.7)	7.1-11.5(9.2)	7.1-14.6(8.8)	5.5-14.6(9.1)
IBW	13.6	5.7-16.6(8.3)	7.1-12.2(8.7)	7.2-14.3(8.4)	5.7-16.6(8.7)
ED	6.9	4.9-7.6(5.3)	5.4-6.6(5.9)	4.6-6.9(5.3)	4.6-7.6(5.6)
LHBE	19.5	8.2-20.9(12.0)	10.5-17.3(12.3)	10.0-18.8(12.0)	8.2-20.9(12.5)
OGR	20	14-19(16.0)	15-20(16)	15-19(16.5)	14-20(16.2)
IGR	26	18-27(21.7)	20-27(24)	18-24(21.4)	18-27(21.7)
LS	172	133-172(150.9)	130-164(155)	135-168(148.8)	130-172(150.4)
SALL	23	18-23(20.0)	19-24(20)	18-21(19.8)	18-24(20.2)
SBLL	14	13-16(14.4)	13-16(14)	13-16(14.4)	13-16(14.4)
GRL	2.5	1.1-3.4(1.7)	1.2-1.8(1.5)	1.3-2.4(1.8)	1.1-3.4(1.7)
GFL	7.6	2.3-10.4(4.4)	4.1-6.4(4.5)	3.1-7.0(4.5)	2.3-10.4(4.7)
DFR	11	11-12(11.05)	11(11)	11(11)	11-12(11.03)
VFR	8	7-8(7.98)	8(8)	8(8)	7-8(7.98)
PFR	13	12-14(13.2)	12-14(13)	11-14(13.1)	11-14(13.1)
AFR	15	14-16(15.4)	14-16(15)	13-15(14.1)	13-15(15.1)

Notes: †Ranges (and means) are presented for paratypes. TL: total length; SL: standard length; BD: body depth; DSV: distance between snout and vent; HL: head length; HD: head depth; CPL: caudal peduncle length; CPD: caudal peduncle length; LST: length of snout; IBW: interobital width; ED: eyes diameter; LHBE: length of head behind eyes; OGR: the outer gillrakers; IGR: the inner gillrakers; GRL: gillraker length; GFL: gillfilament length; DFR: dorsal fin rays; VFR: ventral fin rays; LS, SALL, SBLL, PFR, and AFR as in Table 2.

its end not extending to the ventral fin. The ventral fin abdominal site, behind under the dorsal fin. V-origin is nearer to A-origin than P-origin, far away from the terminal of pectoral fin. Caudal fin deeply forked.

Ayu specimens, brownish-yellow dorsally, yellowish on two sides of body, slightly yellowish on ventral area, body without obvious mottles and black dots. Ayu are small-sized going-up river migration fish, living in rivers such as the Baisha river of Qingdao and Biliu river of Liaoning. Late postlarvae and young (standard length shorter than 50–60 mm) live in mouths of river and gulfs along the coast and migrate up the river. Major young and adult fishes live in deep waters of mountain streams and rivers. They feed on benthenic diatom, blue-green alga and green alga. From September to October every year mature Ayu migrate and spawn in deep water areas of rivers. In general the standard length of adult fish is 150–200 mm. The substrate of spawning areas is gravel and egg demersal, forming a blue and black mass and adhering to stone. Parent fishes die after spawning. Young fish go downstream to the sea and migrate back to river in next spring. The flesh of Ayu is fine and tastes good as first-class food. Ayu is mainly distributed in coastal waters of Liaoning, Shandong, Hebei, Zhejiang, Fujian, Guangxi, and Taiwan provinces of China and the Yellow Sea, the East China Sea, the South China Sea, the Tonkin Gulf (Guangxi) and other sea areas.

4.2 Subspecies Differentiation and Historical Reason for Its Forming

China mainland and Japan are separated by the Yellow Sea and the East China Sea, and the Korea Peninsula and Japan by the Japan Sea. Hokkaido of Japan and the Amur River systems were geologically separated earlier. Various islands of Japan, such as Honshu, Kyushu, and Shikoku, were originally linked with the continent in the Tertiary Period, and in the later stage of the Pliocene, the Japan Sea was formed and was very deep. From that time to the present, the southern area of Japan was only once linked with the fresh water of the mainland during the glacier period of the late Pleistocene (Li, 1981), so the native Ayu of Japan and China mainland could evolute independent-

ly, which created the condition for the subspecies differentiation between Ayu of China and Japanese Ayu. Though China mainland and Taiwan Island are now separated by the Taiwan Strait, the strait and the island were originally a part of the mainland till the Pleistocene of the Quaternary Period when orogenic movement was powerful and prosperous. So the Taiwan Strait is comparatively shallow, about 80 m in the deepest area, and has been linked with the mainland many times under the intense glaciations (sea surface was 100 – 150 m lower than that of the present) (Zhao, 1958; Li, 1981), which brought more communication chances for Ayu of Taiwan and China mainland. Morphological characters of Taiwan Ayu are similar to those of China mainland but different from those of Japan. As Shen (1994) pointed out, the main morphological characters of Taiwan Ayu are the same as those of China mainland Ayu because of the insignificant geographic isolation. Since there are no characters that can reach the standard of subspecies differentiation, Ayu of Taiwan is the Taiwan population of Ayu China subspecies. On the other hand the numbers of comb-like teeth on upper and lower jaws, and vertebrae are already surpassing the standard of subspecies differentiation between nominate subspecies of Japan and Chinese Ayu, so they belong to different subspecies.

Differences between Ryukyus subspecies and nominate subspecies were testified by Nishida (1988) and further confirmed by Nakabo (2002). In addition, the comparison made in this article also definitely indicates that the C.D. values of longitudinal scales, and scales above lateral line, and scales below lateral line are all surpassing the standard of subspecies differentiation between them.

From the above analysis, we conclude that the Ayu population of China is a new subspecies that is different from the nominate subspecies and Ryukyus subspecies.

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