



***Sardinella alcyone* n. sp., a new sardine (Teleostei: Clupeiformes: Clupeidae) from the northwestern Pacific Ocean**

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Abstract

The new sardine *Sardinella alcyone* n. sp. is described on the basis of 19 specimens collected from the Ryukyu Islands, Japan and southwestern Taiwan. The new species closely resembles *Sardinella pacifica* Hata & Motomura 2019, both species having lateral scales with centrally discontinuous striae, a dark spot on the dorsal-fin origin, the pelvic fin with 8 rays, deciduous body scales, and very similar numbers of prepelvic and postpelvic scutes, scale rows in the longitudinal series, and pseudobranchial filaments. However, the new species is distinguished from *S. pacifica* by having lower total gill-raker counts on the first, second, third and fourth gill arches, and on the posterior face of the third gill arch (99–112, 97–115, 79–98, 62–77, and 25–31, respectively, vs. 112–137, 112–148, 95–127, 78–106, and 30–43), and greater pectoral fin (20.7–23.4% SL vs. 18.2–20.8%), pelvic fin (11.9–13.1% SL vs. 10.3–11.9%), maxilla (10.8–12.4% SL vs. 9.3–10.9%), lower jaw (11.8–13.4% SL vs. 10.4–11.6%), and pre-anal-fin length (77.4–82.3% SL vs. 72.9–79.3%) proportions.

Key words: morphology, taxonomy, *Sardinella pacifica*, Okinawa, Taiwan

Introduction

Sardinella Valenciennes 1847, an Indo-Pacific and Atlantic genus of marine, brackish and fresh water sardines (Clupeidae), comprises 24 valid species (Whitehead 1985; Stern *et al.* 2016; Hata & Motomura 2019a, b). Four of these, *Sardinella lemuru* Bleeker 1853, *Sardinella melanura* (Cuvier 1829), *Sardinella zunasi* (Bleeker 1854) and the endemic species *Sardinella electra* Hata & Motomura 2019, occur in Japan (Whitehead 1985; Aonuma & Yagishita 2013; Hata & Motomura 2019a), some being an important fisheries resource (Hata 2018).

During a revisionary study of *Sardinella*, 19 specimens of a clupeid fish from Taiwan and the Ryukyu Islands, Japan were found to be characterized by a unique combination of characters, including scales with centrally discontinuous striae, a dark spot on the dorsal-fin origin, low counts of scale rows in the longitudinal series and gill rakers, and longer pectoral and pelvic fins, and both jaws. They are described herein as a new species of *Sardinella*.

Material and methods

Counts and proportional measurements followed Hata & Motomura (2017). All measurements were made to the nearest 0.01 mm using digital calipers. Standard length was abbreviated as SL. Institutional codes follow Sabaj (2016), with a single addition, SPMN (Museum of Natural and Environmental History, Shizuoka, Japan).

***Sardinella alcyone* n. sp.**

[New English name: Blueback *Sardinella*; new standard Japanese name: Shiosai-iwashi]

Figures 1–4; Table 1

Holotype. KAUM-I. 108333, 96.1 mm SL, mouth of Nasada River, Nago, Okinawa Island, Ryukyu Islands, Japan, 26°38'05"N, 128°00'07"E, 1 m depth, 12 Mar. 2017, casting net, K. Shibukawa & M. Nakae.

Paratypes. 18 specimens, 66.6–109.8 mm SL. **JAPAN:** KAUM-I. 108334, 78.4 mm SL, KAUM-I. 108336, 79.3 mm SL, SPMN-NI 44303, 77.4 mm, SPMN-PI 44304, 73.9 mm SL, SPMN-PI 44305, 79.9 mm SL, SPMN-NI 44306, 66.6 mm SL, collected with the holotype; KAUM-I. 108335, 72.2 mm SL, same locality as holotype, collected in 11 Mar. 2017; URM-P 41020, 81.5 mm SL, URM-P 41021, 90.8 mm SL, URM-P 41022, 89.4 mm SL, URM-P 41023, 98.2 mm SL, URM-P 41024, 106.5 mm SL, URM-P 41025, 103.5 mm SL, Nakaoji, Haneji, Okinawa Island, Ryukyu Islands, 9 Nov. 2000. **TAIWAN:** BMNH 1979.3.21.333, 109.8 mm SL, Tainan; KAUM-I. 113218, 77.7 mm SL, KAUM-I. 113219, 83.6 mm SL, KAUM-I. 113782, 90.5 mm SL, KAUM-I. 113784, 80.3 mm SL, off Dong-gang, Pingtung County, 10–50 m depth.



FIGURE 1. Holotype of *Sardinella alcyone* n. sp. KAUM-I. 108333, 96.1 mm SL, Okinawa Island, Ryukyu Islands, Japan.

Diagnosis. A species of *Sardinella* with the following combination of characters: caudal fin with black posterior margin; lateral body scales with centrally discontinuous vertical striae, and few perforations and pores posteriorly; 38–41 (modally 39) scale rows in longitudinal series; body scales deciduous; black spot on dorsal-fin origin; pelvic fin with one unbranched and seven branched rays; gill rakers 34–42 (39) in upper series on 1st gill arch, 64–72 (67) in lower series, 99–112 (103) in total; gill rakers 33–40 (35) in upper series on 2nd gill arch, 64–76 (74) in lower series, 97–115 (101) in total; gill rakers 31–38 (33) in upper series on 3rd gill arch, 48–60 (57) in lower series, 79–98 (84) in total; gill rakers 24–31 (27) in upper series on 4th gill arch, 37–47 (39) in lower, 62–77 (68) in total; gill rakers 25–31 (27) on hind face of third gill arch; 17 or 18 (18) + 12–14 (13) = 30–32 (31) scutes on ventral of body; pectoral fin long, 20.7–23.4% SL; pelvic fin long, 11.9–13.1% SL; upper jaw moderately long, 10.8–12.4% SL; lower jaw moderately long, 11.8–13.4% SL; pre-anal-fin length 77.4–82.3% SL.

Description. Counts and measurements, expressed as percentages of SL, are given in Table 1. Data for the holotype are presented first, followed by paratype data in parentheses. Body oblong, compressed, deepest at dorsal-fin origin. Dorsal profile of body elevated from snout tip to dorsal-fin origin, thereafter decreasing to uppermost point of caudal-fin base. Ventral profile of body curved downward from lower-jaw tip to pelvic-fin insertion, thereafter rounded to ventralmost point of caudal-fin base. Anus on ventral midline, slightly anterior to anal-fin origin, posterior to midpoint of body. Mouth terminal, small, posterior tip of maxilla not reaching vertical through anterior margin of iris. Premaxilla and hypomaxilla without teeth. Ventral margin of maxilla toothed. Lower jaw with several conical teeth anteriorly. Posterior ramus of lower jaw elevated. Second supramaxilla symmetrical. Nostrils close to each other, anterior to orbit. Orbit elliptical, eye and iris round. Eyes covered with adipose eyelid posteriorly. Interorbital space flat. ten (seven to 11) bony striae on top of head. Gill rakers long, slender, with small asperities on anterior surface. Pseudobranchial filaments present. Gill opening with two fleshy outgrowths on posterior margin, a large papilla on ventral margin. Posterior margins of preopercle and opercle smooth. Scales cycloid, thin, deciduous, except for robust ventral scutes. Scales on lateral body surface with several centrally discontinuous vertical striae,

few perforations and pores posteriorly (Fig. 2). Bases of dorsal and anal fins with low scaly sheaths. Predorsal scales paired. No elongate, wing-like scales present beneath normal paired scales. No scales on head and fins, except for a broad triangular sheath of scales on caudal fin. Abdomen from isthmus to anus with 31 (30 to 32) scutes. Predorsal scutes absent. No lateral line. Anteriormost point of pectoral-fin insertion anterior to posteriormost point of opercle. Upper, posterior and ventral margins of pectoral fin nearly straight. Posterior tip of pectoral fin pointed. Pectoral-fin axillary scale present. Posteriormost dorsal-fin ray not filamentous. Anteriormost point of pelvic-fin insertion located directly below base of 7th (7th–10th) dorsal-fin ray. Posterior tip of depressed pelvic fin reaching between vertical through posterior end of dorsal-fin base and anus. Pelvic-fin axillary scale present. Anal-fin origin posterior to vertical through posteriormost point of dorsal-fin base. Two posteriormost anal-fin rays enlarged. Caudal fin forked. Posterior tips of caudal-fin lobes pointed.

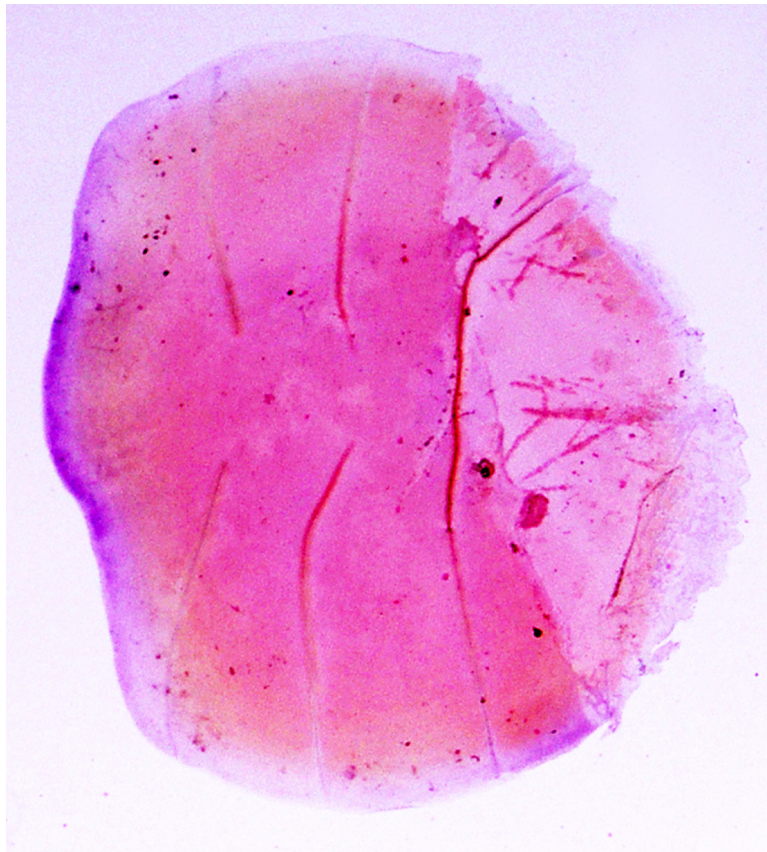


FIGURE 2. Stained lateral body scale removed from *Sardinella alcyone* n. sp. (KAUM-I. 108335, paratype, 72.2 mm SL, Okinawa Island, Ryukyu Islands, Japan).

Coloration when fresh. [Based on color photographs of seven specimens (KAUM-I. 113219, 108333, 108334, 108335, 108336, and SPMN-PI 44303, 44304)]. Dorsum bluish-green (or bluish-black). Lateral surface of body yellowish-silver, upper part metallic blueish. Black spot on dorsal-fin origin. Dorsal fin yellow, melanophores scattered on upper part of fin. Pectoral, pelvic, and anal fins yellowish (or translucent whitish). Caudal fin yellowish, posterior margin black. Black melanophores scattered on caudal-fin rays.

Color of preserved specimens. Body dark brown dorsally, elsewhere yellowish-silver. Black spot on dorsal-fin origin and distal tips of caudal fin lobes. Melanophores scattered on upper part of dorsal fin.

Distribution. Currently known only from Okinawa Island, Ryukyu Islands, Japan and southwestern Taiwan. The species inhabits coastal shallow waters and estuaries.

Etymology. The specific name *alcyone* is derived from Greek meaning “kingfisher”, in reference to the brilliant blueish dorsum of the species.

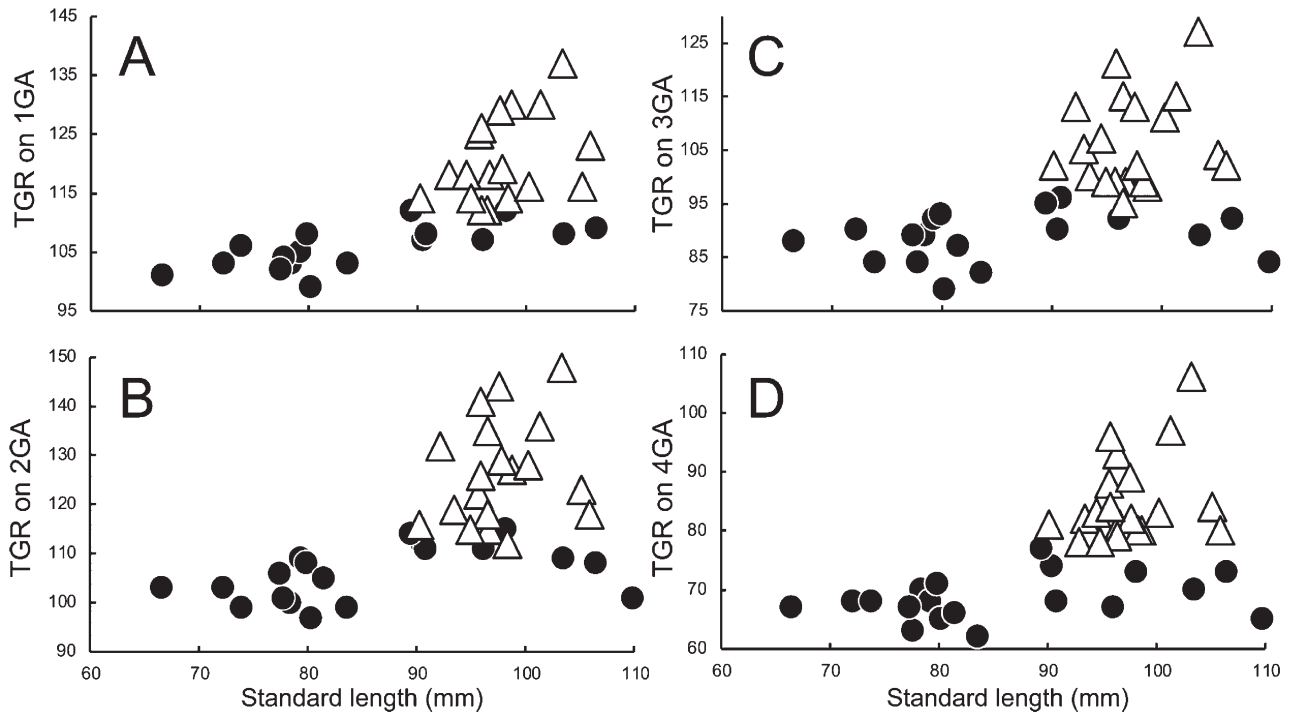


FIGURE 3. Relationships of total gill-raker numbers (TGR) on (A) first gill arch (1GA), (B) second gill arch (2GA), (C) third gill arch (3GA), and (D) fourth gill arch (4GA) relative to standard length in *Sardinella alcyone* n. sp. (closed circles) and *S. pacifica* (open triangles).

TABLE 1. Counts and measurements of specimens of *Sardinella alcyone* n. sp.

	Holotype	Paratypes	
	Japan KAUM-I. 108333	Japan and Taiwan <i>n</i> = 18	Modes
Standard length (SL; mm)	96.1	66.6–109.8	
Counts			
Dorsal-fin rays (unbranched)	4	4–5	4
Dorsal-fin rays (branched)	15	14–16	15
Anal-fin rays (unbranched)	3	3–4	3
Anal-fin rays (branched)	18	16–19	18
Pectoral-fin rays (unbranched)	1	1	1
Pectoral-fin rays (branched)	14	13–16	14
Pelvic-fin rays (unbranched)	1	1	1
Pelvic-fin rays (branched)	7	7	7
Gill rakers on 1st gill arch (upper)	39	34–42	39
Gill rakers on 1st gill arch (lower)	68	64–72	67
Gill rakers on 1st gill arch (total)	107	99–112	103
Gill rakers on 2nd gill arch (upper)	37	33–40	35
Gill rakers on 2nd gill arch (lower)	74	64–76	74
Gill rakers on 2nd gill arch (total)	111	97–115	101
Gill rakers on 3rd gill arch (upper)	35	31–38	33
Gill rakers on 3rd gill arch (lower)	57	48–60	57

...Continued on next page

TABLE 1. (Continued)

	Holotype	Paratypes	
	Japan KAUM-I. 108333	Japan and Taiwan <i>n</i> = 18	
Gill rakers on 3rd gill arch (total)	92	79–98	84
Gill rakers on 4th gill arch (upper)	27	24–31	27
Gill rakers on 4th gill arch (lower)	40	37–47	39
Gill rakers on 4th gill arch (total)	67	62–77	68
Gill rakers on posterior face of 3rd gill arch	26	25–31	27
Prepelvic scutes	18	17–18	18
Postpelvic scutes	13	12–14	13
Total scutes	31	30–32	31
Scale rows in longitudinal series	38	38–41	39
Pseudobranchial filaments	18	16–20	17
Measurements (%SL)			Means
Head length	26.6	24.7–28.6	27.1
Body depth	34.3	26.4–36.8	31.1
Pre-dorsal-fin length	46.0	43.4–46.8	45.4
Snout tip to pectoral-fin insertion	27.1	26.5–29.1	27.7
Snout tip to pelvic-fin insertion	55.2	51.9–56.4	54.4
Pre-anal-fin length	81.6	77.4–82.3	80.3
Dorsal-fin base length	15.8	14.3–17.1	15.8
Anal-fin base length	15.0	14.9–18.4	16.4
Caudal-peduncle length	6.7	6.1–9.6	7.4
Caudal-peduncle depth	9.6	8.2–11.8	9.9
D–P ₁	34.1	32.6–34.9	32.7
D–P ₂	33.1	25.6–36.0	30.2
D–A	44.0	39.6–47.0	42.5
P ₁ –P ₂	29.4	25.6–29.3	28.2
P ₂ –A	30.4	27.5–30.9	28.7
Pectoral-fin length	21.9	20.7–23.4	21.8
Pelvic-fin length	12.1	11.9–13.1	12.4
Interorbital width	4.5	4.1–4.9	4.6
Postorbital length	11.8	11.2–12.4	11.8
Upper-jaw length	11.9	10.8–12.4	11.6
Mandible length	12.2	11.8–13.4	12.5

Remarks. *Sardinella alcyone* is assignable to the genus *Sardinella*, defined by Whitehead (1985) and Munroe *et al.* (1999), due to its compressed body, abdomen covered with prominently keeled scutes, paired predorsal scales, a symmetrical second supramaxilla, toothless hypomaxilla, two enlarged posteriormost anal-fin rays, the dorsal fin without filamentous rays, and two fleshy outgrowths on the hind margin of the gill opening. The new species most closely resembles *Sardinella pacifica*, sharing centrally discontinuous striae on the lateral body scales, a dark spot on the dorsal-fin origin, more than 63 lower gill rakers on the first gill arch, 8 pelvic-fin rays, 17 or 18 prepelvic scutes, and more than 13 pseudobranchial filaments (Whitehead 1985; Munroe *et al.* 1999; Stern *et al.* 2016; Hata & Motomura 2019a, b). However, *S. alcyone* is distinguished from the latter by the number of gill-rakers on the first to fourth gill arches (Table 1; Fig. 3), and greater pectoral fin (20.7–23.4% SL vs. 18.2–20.8% in *S. pacifica*; Fig.

4A), pelvic fin (11.9–13.1% SL vs. 10.3–11.9%; Fig. 4B), maxilla (10.8–12.4% SL vs. 9.3–10.9%; Fig. 4C), lower jaw (11.8–13.4% SL vs. 10.4–11.6%; Fig. 4D) and pre-anal-fin length (77.4–82.3% SL vs. 72.9–79.3%; Fig. 4E) proportions (Hata & Motomura 2019b; this study).

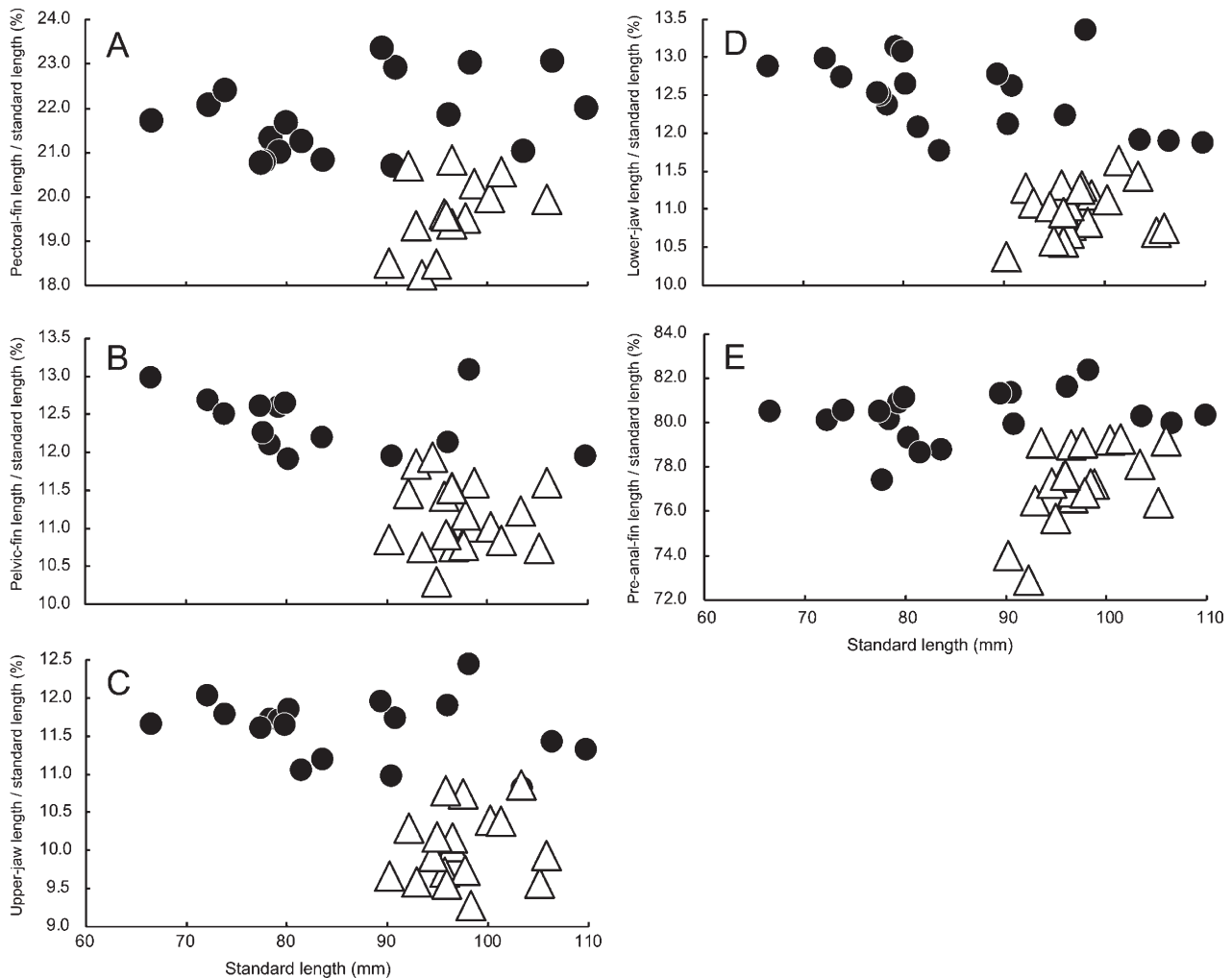


FIGURE 4. Relationships of (A) pectoral-fin length (as % of standard length; SL) to SL, (B) pelvic-fin length (as % of SL) to SL, (C) upper-jaw length (as % of SL) to SL, (D) lower-jaw length (as % of SL) to SL, and (E) pre-anal-fin length (as % of SL) to SL in *Sardinella alcyone* n. sp. (closed circles) and *S. pacifica* (open triangles).

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