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FULL PAPER

Two new species of *Thrissina* (Clupeiformes: Engraulidae) from the northern Indian Ocean and redescription of *Thrissina vitrirostris* (Gilchrist and Thompson 1908)

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Abstract
Thrissina cultella sp. nov., and *Thrissina serena* sp. nov., are described from the Bay of Bengal and northwestern Indian Ocean, respectively. Although both species resemble *T. vitrirostris* (Gilchrist and Thompson 1908), which is redescribed from both type and non-type specimens, in having a long upper jaw (posterior tip reaching to pectoral-fin insertion) and similar numbers of gill rakers and ventral scutes, the two new species differ in having fewer transverse scales (9–10 in both vs. 11–12 in *T. vitrirostris*). *Thrissina cultella* differs from *T. serena* in having a slender body [24.4–26.9% of standard length (SL) vs. 26.6–29.4% SL in *T. serena*], shorter head (25.2–27.1% SL vs. 26.2–27.3%) and pectoral fin (17.5–19.1% SL vs. 19.5–21.3%), and longer pelvic fin (9.3–10.5% SL vs. 7.8–8.7%).

Keywords Teleostei · Morphology · Taxonomy · *Thryssa* · *Thrissina adelae*

Introduction

Thrissina Jordan and Seale 1925, an Indo-Pacific genus of marine and/or brackish water anchovies, previously regarded as the incorrect spelling *Thryssa* Cuvier 1829 (Kottelat 2013), includes 24 valid species and is characterized as follows: compressed body; abdomen covered with prominently keeled prepelvic and postpelvic scutes; a predorsal scute; jaw teeth small, not canine-like; upper pectoral-fin ray not extended as a filament; and anal fin long, with 25–45 branched rays (Whitehead et al. 1988; Wongratana et al. 1999; Kottelat 2013).

During a revisionary study of *Thrissina*, a number of engraulid specimens from the Bay of Bengal and northwestern Indian Ocean, respectively, were identified as new to science. Comprising two previously unrecognized species, they were similar to *Thrissina vitrirostris* (Gilchrist and Thompson 1908) and *Thrissina adelae* (Rutter 1897) in having the first supramaxilla minute, a long maxilla, extending posteriorly beyond the first pectoral-fin ray insertion but only slightly beyond the lower pectoral-fin insertion, fewer than 40 branched anal-fin rays, and more than 20 lower gill rakers on the first gill arch (see Whitehead et al. 1988; Wongratana et al. 1999; this study). The two new species are described, and *T. vitrirostris* is redescribed.

Materials and methods

Counts and proportional measurements generally followed Hata and Motomura (2017), transverse scales not including ventral and predorsal scutes. All measurements were made with digital calipers to the nearest 0.01 mm. Standard length was abbreviated as SL. Counts and measurements, expressed as percentages of SL, are given in Tables 1 and 2. Institutional codes follow Sabaj (2016).

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Table 1 Meristics of specimens of *Thrissina vitrirostris*, *T. adelae*, *T. cultella*, sp. nov., and *T. serena*, sp. nov

	Thrissina vitrirostris				*Thrissina adelae*		*Thrissina cultella*, sp. nov.			*Thrissina serena*, sp. nov.		
	Lectotype of *Engraulis vitrirostris*	Paralectotype of *Engraulis vitrirostris*	Non-type specimens		Syntypes of *Trichosoma adelae*		Holotype	Paratypes		Holotype	Paratypes	
	SAM 9932	$n=2$	$n=16$	Modes	$n=8$	Modes	CAS 33932	$n=20$	Modes	USNM 445177	$n=10$	Modes
Standard length (SL; mm)	151.0	immeasurable	83.2–146.4		70.5–96.7		94.9	68.5–114.0		113.8	70.5–132.5	
Dorsal-fin rays (unbranched)	4	4	4	4	4	4	4	4	4	4	4	4
Dorsal-fin rays (branched)	11	11	10–11	11	9–10	10	11	10–11	11	11	10–11	11
Anal-fin rays (unbranched)	4	4	4	4	4	4	4	4	4	4	4	4
Anal-fin rays (branched)	38	38	35–38	37	34–40	40	33	31–34	33	37	34–36	34
Pectoral-fin rays (unbranched)	1		1	1	1	1	1	1	1	1	1	1
Pectoral-fin rays (branched)	12		11–12	12	10–11	11	11	10–12	12	13	11–13	12
Pelvic-fin rays (unbranched)	1	1	1	1	1	1	1	1	1	1	1	1
Pelvic-fin rays (branched)	6	6	6	6	6	6	6	6	6	6	6	6
Caudal-fin rays (upper + lower)	10+9	10+9	10+9	10+9	10+9	10+9	10+9	10+9	10+9	10+9	10+9	10+9
Gill rakers on 1st gill arch (upper)	17		14–16	16	14–15	15	16	15–17	16	17	15–17	15
Gill rakers on 1st gill arch (lower)	22		19–23	20	21–23	21	22	21–23	22	23	20–24	21
Gill rakers on 1st gill arch (total)	39		34–39	34	35–37	37	38	36–39	38	40	35–41	36
Gill rakers on 2nd gill arch (upper)	14		11–15	14	12–13	12	14	12–15	13	15	13–15	14
Gill rakers on 2nd gill arch (lower)	23		20–24	23	20–21	21	23	21–23	22	23	21–24	22
Gill rakers on 2nd gill arch (total)	37		31–38	37	32–34	33	37	33–38	36	38	34–39	35
Gill rakers on 3rd gill arch (upper)	11		9–12	11	8–9	9	11	10–12	12	13	12–13	12
Gill rakers on 3rd gill arch (lower)	11		10–12	12	11–13	11	12	11–14	12	13	12–14	13

Table 1 (continued)

	Thrissina vitrirostris				*Thrissina adelae*		*Thrissina cultella*, sp. nov.			*Thrissina serena*, sp. nov.		
	Lectotype of *Engraulis vitrirostris*	Paralectotype of *Engraulis vitrirostris*	Non-type specimens		Syntypes of *Trichosoma adelae*		Holotype	Paratypes		Holotype	Paratypes	
	SAM 9932	$n=2$	$n=16$	Modes	$n=8$	Modes	CAS 33932	$n=20$	Modes	USNM 445177	$n=10$	Modes
Gill rakers on 3rd gill arch (total)	22		20–24	22	19–22	20	23	21–25	24	26	24–27	25
Gill rakers on 4th gill arch (upper)	10		9–11	10	7–9	7	10	9–11	10	10	8–11	11
Gill rakers on 4th gill arch (lower)	11		9–12	11	9–11	9	11	10–13	12	12	11–12	12
Gill rakers on 4th gill arch (total)	21		18–23	21	16–19	17	21	20–24	23	22	19–23	23
Gill rakers on posterior face of 3rd gill arch	7		6–8	7	5–6	6	8	6–9	8	8	6–9	8
Prepelvic scutes	18		17–18	18	17–18	17	18	17–18	18	17	16–18	17
Postpelvic scutes	9	10	8–11	10	8–10	9	11	10–11	11	12	10–11	11
Total pelvic scutes	27		26–29	27	25–27	26	29	27–29	29	29	27–29	28
Scale rows in longitudinal series	41		41–43	42	42–43	43	40	37–41	38	40	38–41	39
Transverse scales	11	11	11–12	11	10	10	9	9–10	9	10	10	10

Table 2 Morphometrics of specimens of *Thrissina vitrirostris*, *T. adelae*, *T. cultella*, sp. nov., and *T. serena*, sp. nov

	Thrissina vitrirostris			*Thrissina adelae*		*Thrissina cultella*, sp. nov.			*Thrissina serena*, sp. nov.		
	Lectotype of *Engraulis vitrirostris*	Non-type specimens		Syntypes of *Trichosoma adelae*		Holotype	Paratypes		Holotype	Paratypes	
	SAM 9932	$n=16$	Means	$n=8$	Means	CAS 33932	$n=20$	Means	USNM 445177	$n=10$	Means
Standard length (SL; mm)	151.0	83.2–146.4		70.5–96.7		94.9	68.5–114.0		113.8	70.5–132.5	
Head Length	24.2	24.3–26.8	25.4	23.0–24.4	23.8	25.1	25.2–27.1	26.4	27.3	26.2–27.1	26.6
Body depth	29.3	28.3–30.4	29.3	21.8–25.6	24.1	25.1	24.4–26.9	25.9	27.5	26.6–29.4	27.8
Pre-dorsal-fin length	51.5	51.1–59.9	53.6	53.0–54.2	53.5	50.8	51.6–54.9	53.0	53.0	51.8–57.1	53.3
Snout tip to pectoral-fin insertion	26.2	26.6–29.0	27.5	25.4–27.0	26.2	27.5	27.3–29.3	28.5	29.7	28.3–29.7	29.1
Snout tip to pelvic-fin insertion	42.4	41.1–45.1	43.3	40.0–42.0	41.0	42.6	40.5–45.0	43.5	44.5	42.8–46.6	44.6
Snout to anal-fin origin	62.8	60.9–66.8	63.1	57.6–63.4	59.9	61.1	61.9–67.7	64.1	65.7	63.5–67.0	65.4
Distance from dorsal-fin origin to pectoral-fin insertion	37.9	34.9–38.5	36.5	34.1–37.4	35.2	34.1	33.4–37.2	35.1	35.3	34.4–36.9	35.8
Distance from dorsal-fin origin to pelvic-fin insertion	30.8	29.4–31.4	30.5	25.7–28.8	27.0	29.0	26.2–31.9	28.4	31.8	27.4–32.4	30.3
Distance between origins of dorsal and anal fins	30.3	26.1–30.7	29.1	22.1–25.0	23.9	24.9	24.9–27.7	26.5	29.3	26.3–29.1	28.1
Distance between insertions of pectoral and pelvic fins	17.8	14.7–18.9	16.6	14.7–17.0	15.8	15.8	13.0–17.9	15.6	14.2	14.3–18.3	16.4
Distance from pelvic-fin insertion to anal-fin origin	22.0	17.9–24.3	21.3	16.4–22.7	18.4	21.3	18.4–23.8	21.9	24.4	20.8–26.4	23.7
Dorsal-fin base length	9.8	8.6–10.6	9.8	7.8–8.9	7.6	9.0	9.0–10.6	9.8	10.2	9.6–10.9	10.1
Anal-fin base length	34.8	30.7–36.6	34.0	32.9–37.4	35.2	30.0	28.6–32.2	30.6	31.5	28.6–33.1	31.0
Caudal-peduncle length	6.9	6.1–9.1	7.9	6.5–8.9	7.6	7.1	6.9–9.7	8.4	8.1	7.0–8.5	7.8
Caudal-peduncle depth	8.1	8.1–10.3	9.5	8.3–10.5	9.2	9.2	8.7–10.5	9.8	9.4	8.7–9.9	9.5
Pectoral-fin length	broken	19.7–22.1	20.4	17.6–17.8	17.7	18.0	17.5–19.1	18.6	21.3	19.5–21.1	20.3
Pelvic-fin length	7.6	7.6–9.2	8.5	8.0	8.0	9.4	9.3–10.5	9.7	8.6	7.8–8.6	8.2
Interorbital width	5.4	5.8–6.6	6.2	5.7–6.3	5.9	5.8	6.1–7.1	6.5	6.0	5.8–6.4	6.2
Upper-jaw length	27.7	26.2–30.0	28.0	26.3–28.2	27.3	23.9	24.9–28.3	26.6	28.9	24.6–27.8	26.7
Mandibular length	17.9	18.5–20.5	19.6	17.7–18.5	18.1	18.3	18.6–20.1	19.2	20.2	19.0–20.3	19.7
Orbit diameter	6.4	6.4–7.8	7.0	6.3–7.3	6.8	6.6	6.6–7.8	7.2	7.8	7.0–7.9	7.5
Eye diameter	5.6	5.3–6.6	5.9	5.4–6.6	6.2	5.9	5.2–6.6	6.1	6.5	5.8–6.7	6.2
Snout length	4.4	4.1–5.2	4.6	4.1–5.0	4.5	4.8	4.6–5.1	4.9	4.9	4.4–5.1	4.7
Postorbital length	15.1	14.3–15.6	14.9	12.7–13.2	12.9	14.6	14.5–15.8	15.2	15.3	14.1–16.0	15.5

Fig. 1 **a** Lectotype of *Engraulis vitrirostris*, SAM 9932, 151.0 mm SL, Inner Harbour, Durban, South Africa and paralectotypes, **b** SAM 9746, **c** SAM 9931, Natal, South Africa

Thrissina vitrirostris (Gilchrist and Thompson 1908)

(English name: Grass-nose Thryssa) (Fig. 1; Tables 1, 2)

Engraulis vitrirostris Gilchrist and Thompson 1908: 201 (original locality: Inner Harbour, Durban, and KwaZulu-Natal, South Africa; type locality: Inner Harbour, Durban, South Africa, based on newly designated lectotype).

Thryssa vitrirostris: Losse 1966: 177 (Dar-es-Salaam, Ruvu Estuary, Pangani Estuary, and Zanzibar, Tanzania; Mombasa, Malindi and Formosa Bay, Kenya); Losse 1968: 111, pl. 4b (Dar-es-Salaam, Ruvu Estuary, and Zanzibar, Tanzania; Mombasa, Malindi and Formosa Bay, Kenya); Whitehead 1972: 233 (in part: Natal, South Africa and Madagascar); Whitehead and Wongratana 1984: ENGR Thrys 2 1983: (in part: eastern coast of Africa); Whitehead et al. 1988: 445 (in part: eastern coast of Africa).

Lectotype of *Engraulis vitrirostris*. SAM 9932 (Fig. 1a), 151.0 mm SL, Inner Harbour, Durban, South Africa, 15 Feb. 1901, P. Faure.

Paralectotypes. SAM 9746, 9931, heads removed (Fig. 1b, c), Natal, South Africa.

Non-type specimens (16 specimens, 83.2–146.4 mm SL): **KENYA:** CAS 58502, 4 specimens, 93.5–109.2 mm SL, Mombasa; **MOZAMBIQUE:** USNM 427828, 136.7 mm SL, Lourenco Marques, Maputo, Delagoa Bay (26°17'S, 32°49'E), 2–5 m depth; USNM 445178, 6 specimens, 106.9–145.3 mm SL, Ponta Maboul; **MADAGASCAR:** USNM 171059, 2 specimens, 83.2–90.5 mm SL; USNM 301506, 2 specimens, 128.5–146.4 mm SL, Tamatave (18°10'S, 49°25'E); **SOUTH AFRICA:** CAS-SU 31318, 112.9 mm SL, Durban, Natal.

Diagnosis. A species of *Thrissina* with the following combination of characters: upper jaw long, its posterior tip beyond the first pectoral-fin ray insertion but only slightly beyond posteriormost pectoral-fin base insertion; first supramaxilla minute, oval; dorsal fin with 10–11 (modally 11) branched rays; anal fin with 35–38 (37) branched rays; pectoral fin with 11–12 (12) branched rays; transverse scales 11–12 (11); scale rows in longitudinal series 41–43 (42); gill rakers 14–17 (16) in upper series on first gill arch, 19–23 (20) in lower series, 34–39 (34) in total; gill rakers 11–15 (14) in upper series on second gill arch, 20–24 (23) in lower series, 31–38 (37) in total; gill rakers 9–12 (11) in upper series on third gill arch, 10–12 (12) in

lower series, 20–24 (22) in total; gill rakers 9–11 (10) in upper series on fourth gill arch, 9–12 (11) in lower series, 18–23 (21) in total; head rather short, 24.2–26.8% SL; body deep, depth 28.3–30.4% SL; pectoral fin long, length 19.7–22.1% SL; pelvic fin rather short, length 7.6–9.2% SL.

Description. Data for the lectotype presented first, followed by other specimen data in parentheses (if different). Body strongly compressed laterally, greatest depth at dorsal-fin origin. Dorsal profile of head and body slightly convex from snout tip to dorsal-fin origin, gently lowering to uppermost point of caudal-fin base. Ventral profile of head and body lowering from lower-jaw tip to anteriormost point of pelvic-fin insertion, almost parallel to body axis from pelvic-fin insertion to anal-fin origin, rising to lowermost point of caudal-fin base. Abdomen rounded, covered by 18 (17 or 18) and 9 (8 to 11) sharp needle-like scutes from isthmus to pelvic scute, and pelvic scute to anus, respectively. A single spine-like scute on dorsal-fin origin. Anus just anterior to anal-fin origin. Caudal peduncle compressed, its depth greater than orbit diameter. Head large, compressed. Snout length much less than orbit diameter. Snout tip rounded, slightly above horizontal level of eye center. Interorbital space flat. Mouth large, inferior, below body axis, extending backward beyond posterior margin of eye. Lower jaw slender, much shorter than upper jaw. Upper jaw long, posterior tip of maxilla pointed, slightly beyond (or not reaching to) pectoral-fin base. First supramaxilla minute, oval. Single rows of conical teeth on both jaws. Several conical teeth on vomer. Eye large, round, covered with adipose eyelid, lateral on head, dorsal to horizontal through pectoral-fin insertion, visible in dorsal and ventral views; pupil round. Orbit elliptical. Nostrils close to each other, anterior to anterior margin of orbit and above horizontal through midline of body. Posterior margin of preopercle smooth. Subopercle with rounded posterior margin. Opercular membrane without serrations. Pseudobranchial filaments present, covered with fleshy membrane. Gill rakers long, slender. Serrae on gill rakers clumped. Gill membrane on each side joined distally, most isthmus muscle exposed (not covered by gill membrane). Scales absent on head and fins. Lateral line absent. Dorsal-fin origin posterior to pelvic-fin insertion, anterior to anal-fin origin. Anal-fin origin posterior to vertical through posteriormost dorsal-fin base (just below base of 13th or 14th dorsal-fin ray in some non-type specimens). Caudal fin forked. Uppermost pectoral-fin ray unbranched, inserted below horizontal through midline of body; posterior tip of pectoral fin slightly beyond anteriormost point of pelvic-fin insertion. Pelvic fin shorter than pectoral fin. Posterior tip of depressed pelvic fin not reaching anus or vertical through dorsal-fin origin.

Coloration of preserved specimens. Head and body almost uniformly pale brown. No melanophores on the body of the lectotype (dark black blotch behind upper part of gill opening. Numerous black melanophores scattered on dorsum, dorsal fin and caudal fin. Outer margin of caudal fin black).

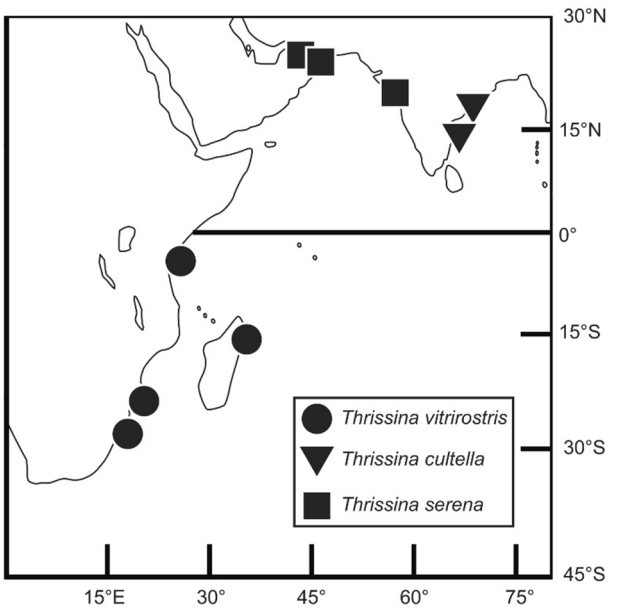

Fig. 2 Distributional records of *Thrissina vitrirostris* (circles), *T. cultella* sp. nov. (triangles), and *T. serena* sp. nov. (squares), based on specimens examined in this study

Distribution. Known from the east coast of Africa from Kenya to Natal, South Africa, and off Madagascar (Fig. 2).

Comparisons. This species differs from all other congeners, except for *Thrissina adelae* (Fig. 3), *Thrissina cultella* sp. nov. and *T. serena* sp. nov. by having a long upper jaw, the posterior tip beyond the first pectoral-fin ray insertion but only slightly beyond the posteriormost pectoral-fin insertion; a minute first supramaxilla; and the anal fin with 35–38 branched rays (Whitehead et al. 1988; Wongratana et al. 1999). *Thrissina vitrirostris* differs from the above three species by having higher counts of transverse scales (11–12 in *T. vitrirostris* vs. 10 in *T. adelae*; 9–10 in *T. cultella*; 10 in *T. serena*), and from *T. adelae* in having a longer head (24.2–26.8% SL in *T. vitrirostris* vs. 23.0–24.4% in *T. adelae*; Fig. 4a), deeper body (28.3–30.4% SL vs. 21.8–25.6%; Fig. 4b), longer pectoral fin (19.7–22.1% SL vs. 17.6–17.8%; Fig. 4c), and more branched dorsal-fin [10–11 (modally 11) vs. 9–10 (10)] and branched pectoral-fin rays [11–12 (12) vs. 10–11 (11); Table 1]. More detailed comparisons of *T. vitrirostris* with *T. cultella* and *T. serena* are given under Comparisons for the latter species, respectively.

Remarks. *Thrissina vitrirostris* was described as *Engraulis vitrirostris* by Gilchrist and Thompson (1908), based on three South African specimens. SAM 9746 and 9931, from Natal, both lack heads (Fig. 1b, c). The third specimen

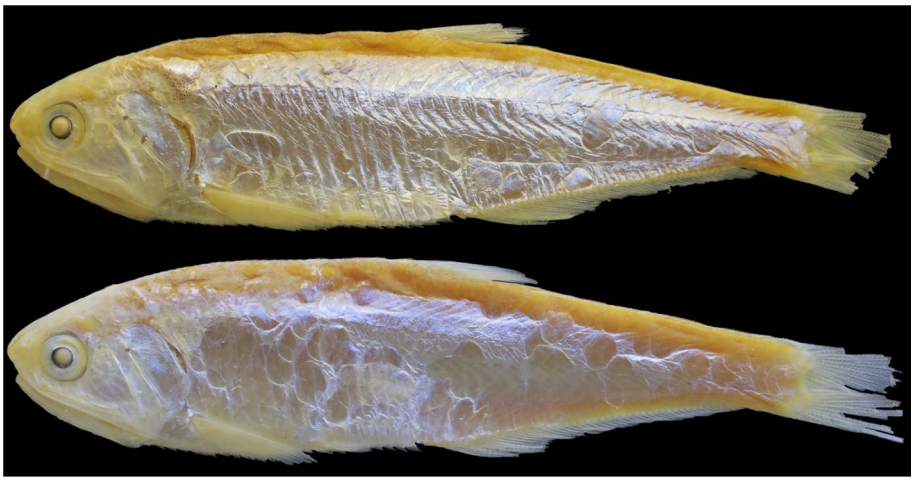

Fig. 3 Syntypes of *Trichosoma adelae*. CAS 1565 (upper), 96.7 mm SL, (lower), 88.1 mm SL, Swatow, China

(SAM 9932), collected from Durban, has a complete body (Fig. 1a). Due to lacking their head, the first and second specimens are unidentifiable. For nomenclatural stability, the syntype (SAM 9932) from Durban was designated herein as the lectotype of *E. vitrirostris*. The remaining two syntypes become paralectotypes of *E. vitrirostris,* and Inner Harbour, Durban, South Africa, is the type locality of the nominal species.

Although *T. vitrirostris* is regarded as being widely distributed in the Indian Ocean, from the eastern coast of Africa to the Bay of Bengal (Whitehead et al. 1988), examples of the species have, in fact, only been collected off the eastern coast of Africa and Madagascar, and the species is likely therefore to be endemic to this region.

Thrissina cultella sp. nov.

(New English name: Cutlass Thryssa) (Fig. 5; Tables 1, 2)

Thrissocles vitrirostris (not of Gilchrist and Thompson): Dutt 1961: 104 (Waltair, India).

Thryssa vitrirostris (not of Gilchrist and Thompson): Whitehead 1972: 233 [in part: Bombay (currently Mumbai) and Waltair, India]; Whitehead and Wongratana 1984: ENGR Thrys 2 1983: (in part: eastern coast of India); Whitehead et al. 1988: 445 (in part: eastern coast of India); De Bruin et al. 1994: 194 (Sri Lanka).

Holotype. CAS 33932, 94.9 mm SL, Chennai, Tamil Nadu State, Bay of Bengal, India, 13°04′51″N, 80°17′58″E, ca. 16.5–22.0 m depth, Apr. 1975, trawl, collected by K. V. Rama Rao.

Paratypes. 20 specimens, 68.5–114.0 mm SL. CAS 246241, 13 specimens, 68.5–96.4 mm SL, CAS 53197, 86.4 mm SL, KAUM–I. 128243, 99.3 mm SL, KAUM–I. 128244, 90.3 mm SL, KAUM–I. 128245, 91.7 mm SL, collected with the holotype; CAS 41551, 105.2 mm SL, Bimlipatnam, Vishakhapatnam, Andhra Pradesh State, India; USNM 276495, 109.1 mm SL, Muthupet, Chennai, Tamil Nadu State, Bay of Bengal, India; USNM 276476, 114.0 mm SL, Chennai, Tamil Nadu State, Bay of Bengal, India.

Diagnosis. A species of *Thrissina* with the following combination of characters: upper jaw long, its posterior tip beyond the first pectoral-fin ray insertion but not reaching to posteriormost pectoral-fin insertion; first supramaxilla minute, oval; dorsal fin with 10–11 (modally 11) branched rays; anal fin with 31–34 (33) branched rays; pectoral fin with 10–12 (12) branched rays; transverse scales 9–10 (9); scale rows in longitudinal series 37–41 (38); gill rakers 15–17 (16) in upper series on first gill arch, 21–23 (22) in lower series, 36–39 (38) in total; gill rakers 12–15 (13) in upper series on second gill arch, 21–23 (22) in lower series, 33–38 (36) in total; gill rakers 10–12 (12) in upper series on third gill arch, 11–14 (12) in lower series, 21–25 (24) in total; gill rakers 9–11 (10) in upper series on fourth gill arch, 10–13 (12) in lower series, 20–24 (23) in total; head rather short, length 25.2–27.1% SL; body deep, depth 24.4–26.9% SL; pectoral fin short, length 17.5–19.1% SL; pelvic fin rather long, length 9.3–10.5% SL; dorsal-fin base long, length 9.0–10.6% SL, anal-fin base short, length 28.6–32.2% SL; lower jaw rather long, length 18.3–20.1% SL.

Description. Data for the holotype presented first, followed by paratype data in parentheses (if different). Body strongly compressed laterally, greatest depth at dorsal-fin origin. Dorsal profile of head and body gently elevated from snout tip to dorsal-fin origin, gently lowering to uppermost point of caudal-fin base. Ventral profile of head and body lowering from lower-jaw tip to anteriormost point of pelvic-fin insertion, rising from anal-fin origin to lowermost point of caudal-fin base. Abdomen rounded, covered by 18 (17 or 18) and 11 (10 or 11) sharp needle-like scutes from isthmus to pelvic scute, and pelvic scute to anus, respectively. A single spine-like scute on dorsal-fin origin. Anus situated

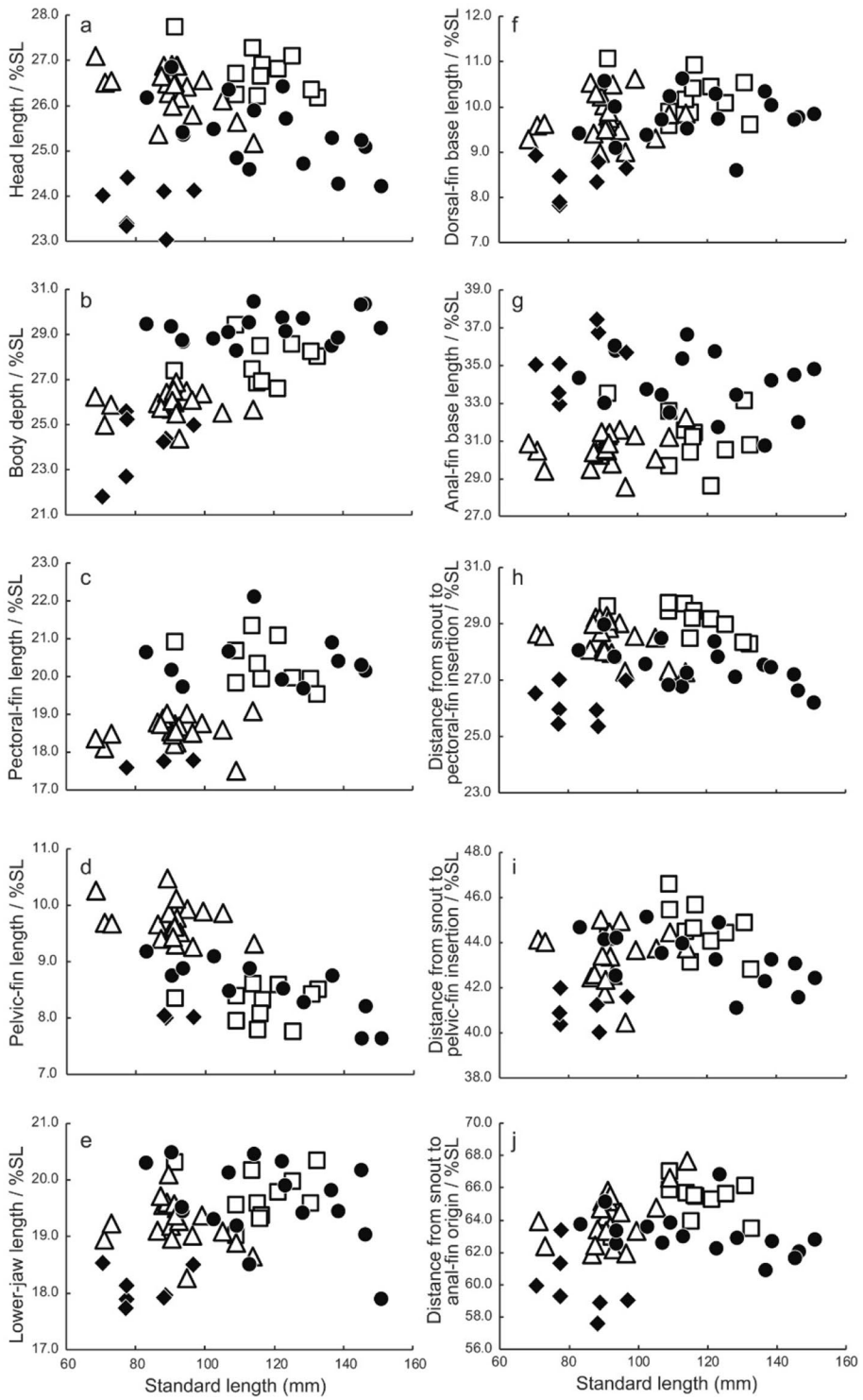

Fig. 4 Morphometrics of *Thrissina vitrirostris* (circles), *T. adelae* (diamonds), *T. cultella* sp. nov. (open triangles), and *T. serena* sp. nov. (open squares). Relationships of **a** head length, **b** body depth, **c** pectoral-fin length **d** pelvic-fin length **e** dorsal-fin base length, **f** anal-fin base length, **g** lower-jaw length, **h** distance from snout tip to pectoral-fin insertion **i** distance from snout tip to pelvic-fin insertion, **j** distance from snout tip to anal-fin origin (all in % of SL) vs. SL

Fig. 5 Holotype of *Thrissina cultella* sp. nov. CAS 33932, 94.9 mm SL, Chennai, eastern coast of India

Fig. 6 Holotype of *Thrissina serena* sp. nov. USNM 445177, 113.8 mm SL, south of Jiwani, southwestern Pakistan

just anterior to anal-fin origin. Caudal peduncle compressed, its depth greater than orbit diameter. Head large, compressed. Snout length much less than orbit diameter. Snout tip rounded, slightly above horizontal level of eye center. Interorbital space flat. Mouth large, inferior, ventral to body axis, extending backward beyond posterior margin of eye. Lower jaw slender, much shorter than upper jaw. Upper jaw long, posterior tip of maxilla pointed, beyond anteriormost point of pectoral-fin insertion, not reaching to posteriormost pectoral-fin insertion. First supramaxilla minute, oval. Single rows of conical teeth on both jaws. Several conical teeth on vomer. Eye large, round, covered with adipose eyelid, lateral on head, dorsal to horizontal through pectoral-fin insertion, visible in dorsal and ventral views; pupil round. Orbit elliptical. Nostrils close to each other, positioned anterior to anterior margin of orbit and above horizontal through midline of body. Posterior margin of preopercle smooth. Subopercle with rounded posterior margin. Opercular membrane without serrations. Pseudobranchial filaments present, covered with fleshy membrane. Gill rakers long, slender. Serrae on gill rakers clumped. Gill membrane on each side joined distally, most isthmus muscle exposed (not covered by gill membrane). Scales absent on head and fins. Lateral line absent. Dorsal-fin origin posterior to posteriormost pelvic-fin insertion, anterior to anal-fin origin. Anal-fin origin posterior to vertical through posteriormost dorsal-fin base (just below base of 12th to 15th dorsal-fin ray in some paratypes). Caudal fin forked. Uppermost pectoral-fin ray unbranched, inserted below horizontal through midline of body; posterior tip of pectoral fin slightly beyond anteriormost point of pelvic-fin insertion. Pelvic fin shorter than pectoral fin. Posterior tip of depressed pelvic fin not reaching to anus or vertical through dorsal-fin origin.

Coloration of preserved specimens. Head and body almost uniformly pale brown. Lower part of lateral surface of body whitish-silver. Dark black blotch behind upper part of gill opening. Numerous melanophores scattered on dorsum, dorsal fin and caudal fin. Outer margin of caudal fin black.

Distribution. Currently known only from the Bay of Bengal, eastern coast of India (Fig. 2).

Etymology. The specific name "*cultella*" is taken from the Latin word for "cutlass", the long maxilla of the species being reminiscent of such.

Comparisons. This new species is assigned to the genus *Thrissina*, defined by Whitehead et al. (1988) and Wongratana et al. (1999) (see "Introduction"). The species differs from all other congeners, except for *T. adelae*, *T. vitrirostris* and *T. serena* sp. nov. by having the first supramaxilla minute and maxilla extending posteriorly beyond the first pectoral-fin ray insertion (although not beyond the posterior tip of the pectoral fin), the anal-fin with 31–34 branched rays, and 21–23 lower gill rakers on the first gill arch (Whitehead et al. 1988; Wongratana et al. 1999; this study).

Thrissina cultella differs from *T. adelae* in having a longer head (25.2–27.1% SL in *T. cultella* vs. 23.0–24.4% in *T. adelae*; Fig. 4a), pelvic fin (9.3–10.5% vs. 8.0%; Fig. 4d), lower jaw (18.3–20.1% vs. 17.7–18.5%; Fig. 4e), and dorsal-fin base (9.0–10.6% SL vs. 7.8–8.9%; Fig. 4f), a shorter anal-fin base (28.6–32.2% SL vs. 32.9–37.4%; Fig. 4g), higher counts of branched dorsal-fin rays [10–11 (modally 11) vs. 9–10 (10)] and total ventral scutes [27–29 (29) vs. 25–27 (26)], and lower counts of branched anal-fin rays [31–34 (33) vs. 34–40] (Table 1).

Thrissina cultella is distinguished from *T. vitrirostris* by its slender body (24.4–26.9% SL in *T. cultella* vs. 28.3–30.4% in *T. vitrirostris*; Fig. 4b), shorter pectoral fin (17.5–19.1% SL vs. 19.7–22.1%; Fig. 4c), and longer pelvic fin (9.3–10.5% SL vs. 7.6–9.2%; Fig. 4d), in addition to lower counts of branched anal-fin rays [31–34 (modally 33) vs. 35–38 (37)], transverse scales [9–10 (9) vs. 11–12 (11)], and scale rows in longitudinal series [37–41 (38) vs. 41–43 (42)] (Table 1). Comparisons of *T. cultella* with *T. serena* are given under Comparisons for the latter.

Thrissina serena sp. nov.

(English name: Arabian Thryssa) (Fig. 6; Tables 1, 2)

Thryssa vitrirostris (not of Gilchrist and Thompson): Whitehead 1965: 274 (in part: Gulf of Oman); Whitehead and Wongratana 1984: ENGR Thrys 2 1983: (in part: western coast of India to Gulf of Oman); Whitehead et al. 1988:

445 (in part: western coast of India to Gulf of Oman); Psomadakis et al. 2015: 158 (Pakistan).

Holotype. USNM 445177, 113.8 mm SL, south of Jiwani, southwestern part of Pakistan, 24°54′N, 61°51′E, 108–115 m depth, 28 Nov. 1963 (4:58–6:02), RV *Anton Bruun*.

Paratypes. 10 specimens, 70.5–132.5 mm SL. USNM 445168, 91.4 mm SL, south of Konarak, Gulf of Oman, Iran, 25°10′N, 60°27′E, 64.9 m depth, 29 Nov. 1963, RV *Anton Bruun*; KAUM–I. 128345, 125.4 mm SL, KAUM–I. 128346, 116.5 mm SL, USNM 445195, 3 specimens, 109.1–121.2 mm SL, collected with the holotype; USNM 445179, 3 specimens, 109.0–130.8 mm SL, south of Pasabandar, Gulf of Oman, Iran, 24°51′N, 61°31′E, 21 m depth, 28 Nov. 1963, RV *Anton Bruun*; USNM 445197, 132.5 mm SL, northwestern coast of India (20°22′N, 71°47′E), 15 Nov. 1963.

Diagnosis. A species of *Thrissina* with the following combination of characters: upper jaw long, its posterior tip beyond the first pectoral-fin insertion ray but not reaching to the posteriormost pectoral-fin insertion; first supramaxilla minute, oval; dorsal fin with 10–11 (modally 11) branched rays; anal fin with 34–37 (34) branched rays; pectoral fin with 11–13 (12) branched rays; transverse scales 10; scale rows in longitudinal series 38–41 (39); gill rakers 15–17 (15) in upper series on first gill arch, 20–24 (21) in lower series, 35–41 (36) in total; gill rakers 13–15 (14) in upper series on second gill arch, 21–24 (22) in lower series, 34–39 (35) in total; gill rakers 12–13 (12) in upper series on third gill arch, 12–14 (13) in lower series, 24–27 (25) in total; gill rakers 8–11 (11) in upper series on fourth gill arch, 11–12 (12) in lower series, 19–23 (23) in total; body rather deep, depth 26.6–29.4% SL; head rather long, length 26.2–27.3% SL; pectoral fin long, length 19.5–21.3% SL; pelvic fin rather short, length 7.8–8.6% SL; lower jaw long, length 19.0–20.3% SL; dorsal-fin base rather long, length 9.6–10.9% SL; anal-fin base short, length 28.6–33.1%; distances from snout to pectoral-fin insertion, pectoral-fin insertion and anal-fin insertion 28.3–29.7% SL, 42.8–46.6% SL, and 63.5–67.0% SL, respectively.

Description. Data for the holotype are presented first, followed by paratype data in parentheses (if different). Body strongly compressed laterally; greatest body depth at dorsal-fin origin. Dorsal profile of head and body gently elevated from snout tip to dorsal-fin origin, and gently lowering to uppermost point of caudal-fin base. Ventral profile of head and body lowering from lower-jaw tip to anteriormost point of pelvic-fin insertion, rising from anal-fin origin to lowermost point of caudal-fin base. Belly rounded, covered by 17 (16 to 18) and 12 (10 to 12) sharp needle-like scutes from isthmus to pelvic scute, and pelvic scute to anus, respectively. A single spine-like scute on dorsal-fin origin. Anus situated just anterior to anal-fin origin. Caudal peduncle compressed, its depth greater than orbit diameter. Head large, compressed. Snout length much less than orbit diameter. Snout tip rounded, slightly above horizontal level of eye center. Interorbital space flat. Mouth large, inferior, ventral to body axis, extending backward beyond posterior margin of eye. Lower jaw slender, much shorter than upper jaw. Upper jaw long, posterior tip of maxilla pointed, beyond anteriormost point of pectoral-fin insertion, not reaching to posteriormost pectoral-fin insertion. First supramaxilla minute, oval. Single rows of conical teeth on both jaws. Several conical teeth on vomer. Eye large, round, covered with adipose eyelid, lateral on head, dorsal to horizontal through pectoral-fin insertion, visible in dorsal and ventral views; pupil round. Orbit elliptical. Nostrils close to each other, positioned anterior to anterior margin of orbit and above horizontal through midline of body. Posterior margin of preopercle smooth. Subopercle with rounded posterior margin. Opercular membrane without serrations. Pseudobranchial filaments present, covered with fleshy membrane. Gill rakers long, slender. Serrae on gill rakers clumped. Gill membrane on each side joined distally, most isthmus muscle exposed (not covered by gill membrane). Scales absent on head and fins. Lateral line absent. Dorsal-fin origin posterior to posteriormost pelvic-fin insertion, anterior to anal-fin origin. Anal-fin origin posterior to vertical through posteriormost dorsal-fin base (just below base of 14th dorsal-fin ray in some paratypes). Caudal fin forked. Uppermost pectoral-fin ray unbranched, inserted below horizontal through midline of body; posterior tip of pectoral fin slightly beyond anteriormost point of pelvic-fin insertion. Pelvic fin shorter than pectoral fin. Posterior tip of depressed pelvic fin not reaching to anus or vertical through of dorsal-fin origin.

Coloration of preserved specimens. Head and body almost uniformly pale brown. Lower part of lateral surface of body whitish-silver. Dark black blotch behind upper part of gill opening. Numerous black melanophores scattered on dorsum, dorsal fin and caudal fin. Outer margin of caudal fin black.

Distribution. Currently known only from the Gulf of Oman and northwestern coast of India (Fig. 2).

Etymology. The specific name *serena* is derived from Latin meaning "serene", in reference to the serenity of the Arabian Sea, in which the species is distributed.

Comparisons. This new species is assigned to the genus *Thrissina*, defined by Whitehead et al. (1988) and Wongratana et al. (1999) (see "Introduction"), and differs from all other congeners, except for *T. adelae*, *T. vitrirostris* and *T. cultella* sp. nov. by having the first supramaxilla minute and maxilla extending posteriorly beyond the first pectoral-fin ray insertion (but not beyond the posterior tip of the pectoral fin), the anal-fin with 34–37 branched rays, and 20–24 lower gill rakers on the first gill arch (Whitehead et al. 1988; Wongratana et al. 1999; this study).

Thrissina serena differs from *T. adelae* in having a longer head (26.2–27.3% SL in *T. serena* vs. 23.0–24.4% in *T. adelae*; Fig. 4a) and deeper body (26.6–29.4% SL vs. 21.8–25.6%; Fig. 4b), in addition to the following proportions: distance from snout tip to pectoral-fin insertion 28.3–29.7% SL (vs. 25.4–27.0%; Fig. 4h), distance from snout tip to pelvic-fin insertion 42.8–46.6% SL (vs. 40.0–42.0%; Fig. 4i), distance from snout tip to anal-fin origin 63.5–67.0% SL (vs. 57.6–63.4%; Fig. 4j), dorsal-fin base 9.6–10.9% SL (vs. 7.8–8.9%; Fig. 4k), pectoral fin length 19.5–21.3% SL (vs. 17.6–17.8%; Fig. 4c), lower jaw length 19.0–20.3% (vs. 17.7–18.5%; Fig. 4e), and anal-fin base length 28.6–33.1% SL (vs. 32.9–37.4%; Fig. 4g). Meristic differences include: higher counts of branched dorsal-fin rays [10–11 (modally 11) vs. 9–10 (10)], branched pectoral-fin rays [11–13 (12) vs. 10–11 (11)], and total ventral scutes [27–29 (28) vs. 25–27 (26)]; and lower counts of and scale rows in longitudinal series [38–41 (39) vs. 42–43 (43)] (Table 1).

Thrissina serena is easily distinguished from *T. vitrirostris* by having lower counts of transverse scales [10 vs. 11–12 (modally 11)] and scale rows in longitudinal series [38–41 (39) vs. 41–43 (42)] (Table 1). The head length of *T. serena* tends to be greater than that of *T. vitrirostris* (26.2–27.3% SL in *T. serena* vs. 24.2–26.8% in *T. vitrirostris*; Fig. 4a).

Thrissina serena differs from *T. cultella* in having greater body depth (26.6–29.4% SL in *T. serena* vs. 24.4–26.9% in *T. cultella*; Fig. 4b), a longer pectoral fin (19.5–21.3% SL vs. 17.5–19.1%; Fig. 4c), and shorter pelvic fin (7.8–8.6% SL vs. 9.3–10.5%; Fig. 4d), plus a higher count of branched anal-fin rays [34–37 (modally 34) vs. 31–34 (33); Table 1]. Additionally, the head length proportion in *T. serena* tends to be greater than in *T. cultella* (26.2–27.3% SL vs. 25.2–27.1% Fig. 4a).

Comparative material examined. *Thrissina adelae*: CAS 1565, 8 syntypes of *Trichosoma adelae*, 70.5–96.7 mm SL and ca. 100.8 mm SL (snout broken), Swatow, China.

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