Revision of the Indo-West Pacific polynemid fish genus *Eleutheronema* (Teleostei: Perciformes)

Hiroyuki Motomura[1]✉, Yukio Iwatsuki[1], Seishi Kimura[2], and Tetsuo Yoshino[3]

[1] *Division of Fisheries Sciences, Faculty of Agriculture, Miyazaki University, 1-1 Gakuen-kibanadai-nishi, Miyazaki 889-2192, Japan (e-mail: HM, a02113u@cc.miyazaki-u.ac.jp; YI, yuk@cc.miyazaki-u.ac.jp)*
[2] *Fisheries Research Laboratory, Mie University, P.O. Box 11, Wagu, Shima, Mie 517-0703, Japan (e-mail: kimura-s@bio.mie-u.ac.jp)*
[3] *Department of Marine Sciences, Faculty of Science, University of the Ryukyus, 1 Senbaru, Nishihara, Okinawa 903-0213, Japan (e-mail: b985005@sci.u-ryukyu.ac.jp)*

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Abstract A taxonomic revision of the polynemid fish genus *Eleutheronema*, which is redefined, resulted in three species of the genus being regarded as valid: *Eleutheronema rhadinum* (Jordan and Evermann, 1902), having to date been treated as a junior synonym of *E. tetradactylum* (Shaw, 1804) and currently known only from East Asia (China and Japan) where it is endemic; *E. tetradactylum*, a senior synonym of both *Polynemus teria* Hamilton, 1822 and *Polynemus coecus* Macleay, 1878, being a widely distributed Indo-West Pacific species, which ranges from the Persian Gulf to Australia; and *E. tridactylum* (Bleeker, 1845), distributed in Southeast Asia (Thailand, Malaysia, and Indonesia). *Eleutheronema tridactylum* is easily distinguished from both *E. rhadinum* and *E. tetradactylum* owing to the vomer lacking tooth plates in the former [vs. vomer with 2 deciduous tooth plates (in specimens at least over ca. 70 mm SL) in the latter] and lower counts of pectoral filaments (free lower rays, 3 vs. 4) and gill rakers [mode 8 (range 4–10) vs. 12 (10–17) and 13 (6–18) in *E. rhadinum* and *E. tetradactylum*, respectively]. *Eleutheronema rhadinum* clearly differs from *E. tetradactylum* in having higher counts of pored lateral line scales [mode 95 (range 82–95) vs. 73 (71–80) in the latter] and higher scale counts above and below the lateral line [12 (11–14) and 16 (15–17), respectively, vs. 10 (9–12) and 14 (13–15), respectively]. Furthermore, *E. rhadinum* is distinguished from *E. tetradactylum* by having a dense black pectoral fin [vs. vivid yellow in life (except in specimens over ca. 350 mm SL, pectoral fin dusky-yellow) in the latter]. Intraspecific variations and morphological changes with growth of the three species are also discussed.

Key words Polynemidae · Revision · *Eleutheronema rhadinum* · *Eleutheronema tetradactylum* · *Eleutheronema tridactylum*

The polynemid fish genus *Eleutheronema* was first proposed for *Polynemus tetradactylus* Shaw, 1804 by Bleeker (1862a). Subsequently, Bleeker (1862b) described the genus in detail, including 2 species, *Eleutheronema tetradactylum* and *Polynemus tridactylus* Bleeker, 1845.

Eleutheronema tetradactylum, with 4 pectoral filaments (free pectoral fin rays), being the most common and important commercial threadfin in Southeast and South Asia, has been considered as a valid species by numerous researchers (e.g., Menon, 1974; Menon and Babu Rao, 1984; Rainboth, 1996). Three nominal species, *Polynemus teria* Hamilton, 1822, *Polynemus coecus* Macleay, 1878, and *Polydactylus rhadinus* Jordan and Evermann, 1902, have been treated as junior synonyms of *E. tetradactylum* (e.g., Weber and de Beaufort, 1922; Kagwade, 1970). *Eleutheronema tridactylum*, a rare species with only 3 pectoral filaments, has also been regarded as valid (e.g., Weber and de Beaufort, 1922; Myers, 1936; Kottelat et al., 1993). Although the lower number (3) of pectoral filaments has been recognized as a significant character, the species has at no time been described in detail, brief treatments only in general classifications and regional faunal studies having been published.

Eleutheronema rhadinum, with 4 pectoral filaments, is herein regarded as a valid species, characterized by having a higher pored lateral line scale count and black pectoral fin. The species is currently known only from East Asia, being endemic to the area.

Three *Eleutheronema* species, *E. rhadinum*, *E. tetradactylum*, and *E. tridactylum*, are herein redescribed as valid on the basis of type and non-type materials representing wide distributional ranges. Intraspecific variations and morphological changes with growth of the species are also discussed. The genus *Eleutheronema* is also redefined.

Materials and Methods

Counts and measurements followed Hubbs and Lagler (1947), with the following additions and modifications: body depth, vertical distance from first dorsal fin origin to ventral

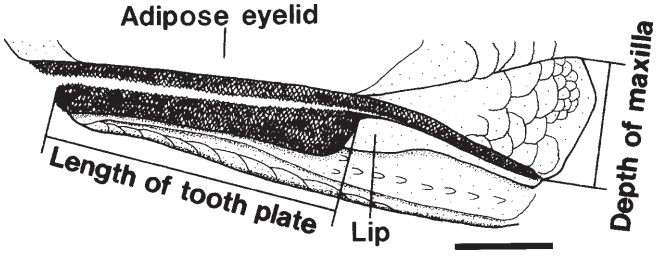

Fig. 1. Left lateral view of upper and lower jaws of *Eleutheronema tetradactylum* (neotype, NSMT-P 60912, 189 mm SL). *Bar* 5 mm

surface; second body depth, distance from second dorsal fin origin to anal fin origin; body width, least distance between pectoral fin bases; dermal eye opening, horizontal distance between fleshy margins of eye; orbit diameter, horizontal distance between bony margins of eye; interorbital width, bony width across frontals above center of eye; depth of maxilla, distance between uppermost and lowermost points on posterior margin of maxilla (see Fig. 1); length of toothplate, distance from anteriormost tip of lower jaw to anterodorsal corner of lower jaw lip (see Fig. 1); and base of pectoral fin, distance from uppermost point of pectoral fin base to lowermost point of pectoral filament base. Counts of pectoral filaments were made from the anteriormost (ventralmost) element. Standard length and total length are expressed as SL and TL, respectively. Terminology of the supraneural bones follows Mabee (1988), and the formula for configuration of the supraneural bones, anterior neural spines, and anterior dorsal fin pterygiophores follows Ahlstrom et al. (1976). The configuration of the supraneural bone, and vertebral, epineural (*sensu* Patterson and Johnson, 1995), and caudal procurrent ray counts were confirmed by radiographs from all ASIZP and FMNH specimens ($n = 8$) of *Eleutheronema rhadinum*, all MUFS specimens ($n = 51$) of *E. tetradactylum*, and all specimens ($n = 34$) of *E. tridactylum*. Institutional codes follow Leviton et al. (1985), with additional institutional abbreviations as follows: Division of Fisheries Sciences, Miyazaki University, Japan (MUFS); Shanghai Fisheries University, China (SFU). Comparative materials for this study are listed in Motomura et al. (1999, 2000a–c, 2001a–g) and Motomura and Iwatsuki (2001a,b).

Genus *Eleutheronema* Bleeker, 1862

Eleutheronema Bleeker, 1862a: 110 (type species: *Polynemus tetradactylus* Shaw, 1804).

Diagnosis. A genus of the family Polynemidae with the following combination of characters: pectoral fin insertion well below midline of body; dermal eye opening greater than snout length; anterior parts of lower jaw with small teeth extending onto lateral surface, adjacent portion of lip absent; width of tooth band on upper and lower jaws greater than space (on symphysis) separating tooth bands on opposing premaxillae; 3 or 4 pectoral filaments, longest filament shorter than pre-1st dorsal fin distance; pectoral fin base length (including base of pectoral filaments) less than upper jaw length; upper and lower caudal fin lobes not filamentous; 10 + 15 vertebrae; swimbladder absent.

Remarks. Bleeker (1862a) proposed *Eleutheronema* (name only) for *Polynemus tetradactylus* Shaw, 1804, but gave neither diagnoses nor descriptions of the genus. Subsequently, Bleeker (1862b) described the genus in detail, including the following characters: body oblong, compressed; scales very small (ca. 70 in lateral line); lip absent except in corner of lower jaw; vomer, palatines, and ectopterygoids with teeth; posterior margin of preopercle serrated; pectoral filaments 3 or 4; anal fin rays 15–17. Two species, *Polynemus tetradactylus* and *Polynemus tridactylus* Bleeker, 1845, were included.

Recently, Feltes (1993) redefined the genera of the family Polynemidae, including a key, and suggested that the posterior extension of tooth plates from the lateral margins of the primary vomerine tooth plate was diagnostic for *Eleutheronema*. However, this character is not found in *E. tridactylum* at any life stage and in juveniles (less than ca. 70 mm SL) of *E. tetradactylum* (see Discussion). Accordingly, the character should be not treated as diagnostic for the genus.

The pectoral fin is inserted well below the midline of the body and the dermal eye opening greater than the snout length in *Eleutheronema*, similar conditions also being found in the following polynemid genera (Feltes, 1993; Motomura and Iwatsuki, 2001a; this study): *Filimanus* Myers, 1936, *Galeoides*, Günther, 1860, *Leptomelanosoma* Motomura and Iwatsuki, 2001, *Pentanemus* Günther, 1860, and *Polydactylus* Lacepède, 1803. The remaining genera recognized to date, *Parapolynemus* Feltes, 1993 and *Polynemus* Linnaeus, 1758, have the pectoral fin inserted near the midline of the body and the dermal eye opening contained twice or more in the snout length (Feltes, 1993).

The dental condition on the lateral surface of the anterior parts of the lower jaw of *Eleutheronema* is similar to that of *Leptomelanosoma*, and larger *Parapolynemus* and *Polydactylus opercularis* (Gill, 1863). However, in *Eleutheronema*, the lip is absent from the anterior part of the lower jaw (Fig. 1), whereas in the latter group the lip is present, although poorly developed (see Motomura and Iwatsuki, 2001a; fig. 2A). Other genera and species have a uniformly well-developed lip on the lower jaw (see Motomura and Iwatsuki, 2001a; fig. 2B).

A distinct character, widths of the tooth bands on the upper and lower jaws greater than the space separating the bands on the opposing premaxillae, is found in all genera of the family, except *Filimanus* and *Pentanemus* in which the space separating the bands on the opposing premaxillae is greater than the widths of the bands on both jaws (Feltes, 1991, 1993; Motomura et al., 2000c).

The number of pectoral filaments of *Eleutheronema* is very few (3 or 4) relative to other members of the family. With the exception of *Polydactylus quadrifilis* (Cuvier *in* Cuvier and Valenciennes, 1829), which has 4 pectoral filaments, other genera and species have 5 or more. Further-

Fig. 2. *Eleutheronema rhadinum* [neotype (ASIZP 60745, 152 mm SL) of *Polydactylus rhadinus* Jordan and Evermann, 1902], from Linkou, Taipei, Taiwan, China

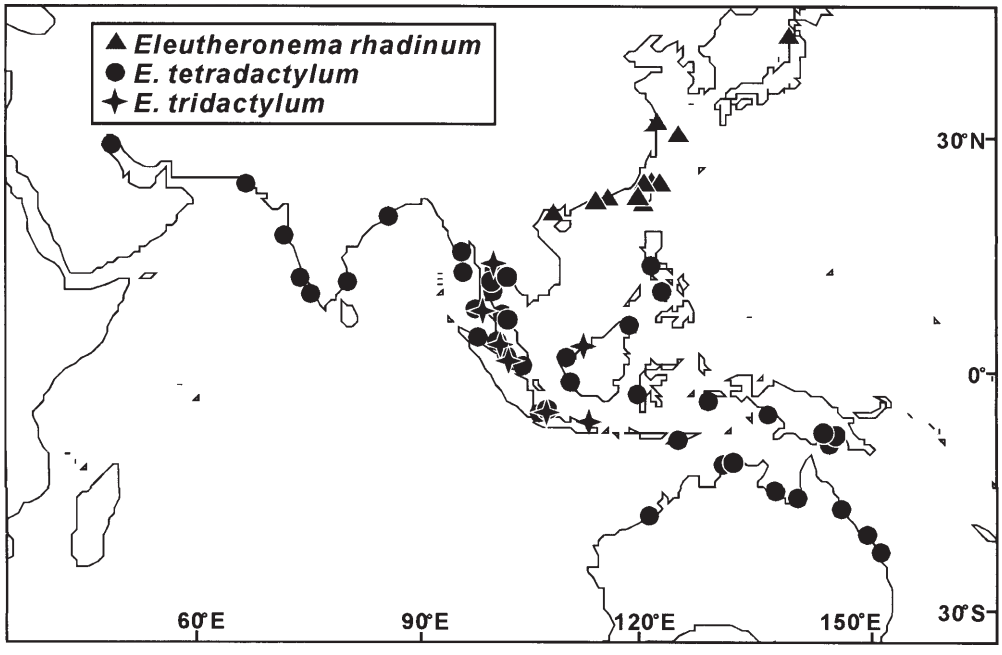

Fig. 3. Geographic distribution of *Eleutheronema rhadinum* (*triangles*), *E. tetradactylum* (*circles*), and *E. tridactylum* (*stars*), based on specimens examined in this study

more, the longest pectoral filaments in all individuals of *Parapolynemus* and *Polynemus*, and in *Polydactylus macrophthalmus* (Bleeker, 1858) exceed their respective standard lengths, whereas those of all other genera, including *Eleutheronema*, and remaining members of *Polydactylus* are less than their respective individual standard lengths (e.g., Feltes, 1993; Motomura and Iwatsuki, 2001a,b; Motomura et al., 2001g).

Although the pectoral fin base length, including the base of the pectoral filaments, of *Galeoides* is greater than the upper jaw length (Feltes, 1993; Motomura et al., 2001b), that of all other genera, including *Eleutheronema*, is less than the upper jaw length (e.g., Motomura et al., 2001a,b; Motomura and Iwatsuki, 2001a).

The upper and lower caudal fin lobes of both *Leptomelanosoma* and *Parapolynemus* are extremely long and filamentous, although easily damaged at the tips. This character is not found in any other polynemids, including *Eleutheronema* (Motomura and Iwatsuki, 2001a). *Eleutheronema* and *Polynemus* have 25 vertebrae (10 abdominal plus 15 caudal vertebrae), whereas all other genera have 24 vertebrae (10 plus 14) (Feltes, 1993; this study).

Eleutheronema species generally occur on continental shelves, having at no time been reported from the vicinity of oceanic islands. The species are considered to be heavily dependent on large freshwater rivers (based on known locality data).

Key to the species of *Eleutheronema*

1a. Pectoral filaments 3; vomer without tooth plates on either side throughout life; second dorsal fin soft rays 13 (rarely 14); gill rakers 4–10 (mode 8) . . . . . *E. tridactylum* (Southeast Asia)

1b. Pectoral filaments 4; vomer with deciduous tooth plates on both sides, except in juveniles (less than ca. 70 mm SL); second dorsal fin soft rays 14 (rarely 13 or 15); gill rakers 6–18 (mode 12 or 13) 2

2a. Pored lateral line scales 82–95; 11–14 (mode 12) scale rows above lateral line, 15–17 (16) below; pectoral fin membranes black when fresh . . . . . *E. rhadinum* (East Asia)

2b. Pored lateral line scales 71–80; 9–12 (mode 10) scale rows above lateral line, 13–15 (14) below; pectoral fin membranes vivid yellow when fresh, except in large specimens (over ca. 350 mm SL) . . . . . *E. tetradactylum* (Indo-West Pacific)

Eleutheronema rhadinum (Jordan and Evermann, 1902)

(New English name: East Asian fourfinger threadfin)
(Japanese name: minami-konoshiro)
(Figs. 2, 3, 7, 9, 11)

Polydactylus rhadinus Jordan and Evermann, 1902: 351, fig. 20 (type locality: Taiwan, China).

Eleutheronema tetradactylum (not of Shaw); Shen, 1984: 98, pl. 98, figs. 361–1a, b (Taiwan); Motomura et al., 2001e: 41, fig. 1 (Japan).

Neotype. ASIZP 60745, 152 mm SL, Linkou, Taipei, Taiwan, China, 5–8 m depth, collected by P.-L. Lin.

Other material. 18 specimens, 82–739 mm SL. AMNH 17795, 82 mm SL, Guangzhou, China; ASIZP 56594, 194 mm SL, Tanshui River, Taipei, Taiwan, China; ASIZP 59836, 149 mm SL, Linkou, Taipei, Taiwan, China; ASIZP 60300, 159 mm SL, Pali, Taipei, Taiwan, China; FMNH 52133 (2 specimens), 208–222 mm SL, Kaohsiung, Taiwan, China; FMNH 91352 (2), 196–235 mm SL, Tanshui River, Taiwan, China; MUFS 18880, 739 mm SL, off Fukaura, Aomori, Sea of Japan, Japan; SFU 3836-3837 (2), 166–194 mm SL, Hong Kong, China; SFU 3838, 102 mm SL, mouth of Qian-tang River, China; SFU 59-1868, 215 mm SL, Choushan Islands, near Shanghai, China; USNM 85481, 230 mm SL, Taiwan, China; ZUMT 13644-13645 (2), 197–211 mm SL, mouth of Tanshui River, Taiwan, China; ZUMT 14955, 210 mm SL, Tainan, Taiwan, China; ZUMT 52237, 246 mm SL, East China Sea (30°30′N, 124°30′E).

Diagnosis. A species of *Eleutheronema* with the following combination of characters: 4 pectoral filaments; 17 or 18 (mode 18, rarely 19) pectoral fin rays; 14 (rarely 13 or 15) second dorsal fin soft rays; 82–95 (mode 95) pored lateral line scales; 11–14 (12) scale rows above lateral line, 15–17 (16) below; 5–8 (5) upper series gill rakers, 5–9 (7) lower, 10–17 (12) total; vomer with deciduous tooth plates on both sides; posterior portion of maxilla deep (3% of SL); short tooth plate extension onto lateral surface of lower jaw [mean 8% (range 8–9%) of SL]; pectoral fin membranes black in fresh.

Description. Counts and proportional measurements as percentages of SL of the neotype of *Polydactylus rhadinus* and other material of *Eleutheronema rhadinum* are given in Table 1. Characters given in the diagnoses of the species and genus are not repeated here. Data for the neotype are presented first, followed by other material data (if different) in parentheses.

Body oblong, compressed; maxilla covered with scales; lip on upper jaw absent; posterior margin of preopercle serrated; posterior margin of maxilla extending well beyond level of posterior margin of adipose eyelid; teeth villiform in broad bands on vomer, palatines, and ectopterygoids; all pectoral fin rays unbranched; fourth pectoral filament longest, not reaching to level of posterior tip of pectoral fin; third pectoral filament extending beyond (same or just short of) level of pelvic fin origin; second pectoral filament extending slightly beyond (same or well beyond) level of pelvic fin origin; first pectoral filament shortest, not reaching to level of pelvic fin origin; posterior tip of pectoral fin just short of level of posterior tip of pelvic fin; all first dorsal fin spine bases of similar thickness (same or base of second spine slightly more robust than others in large specimens); lateral line simple, extending from upper end of gill opening to upper end of lower caudal fin lobe (same or lateral line bifurcating on caudal fin base, upper branch extending to lower end of upper caudal fin lobe and lower branch secondarily bifurcating on middle of lower caudal fin lobe); formula for configuration of supraneural bones, anterior neural spines, and anterior dorsal pterygiophores /0/0 + 2/1/1 + 1/1 + 1/1/ (same, /0/0 + 2/1/1 + 1/1 + 1 + 1/, /0/0 + 2/1 + 1/1/1 + 1/1/, /0/2/1 + 1/1/1 + 1/1/, /0/2/1 + 1/1/1 + 1 + 1/, or /0/2/1 + 1/1 + 1/1/1/); 6 (same or 5) epineurals; 12 (11–13) dorsal and 13 (11–13) ventral series of caudal procurrent rays.

Color when fresh.—Based on color transparencies of ASIZP 59836 (149 mm SL, from China) and MUFS 18880 (739 mm SL, from Japan): upper sides of head and trunk with slight darkish silver tinge, becoming lighter on lower sides; anterior margins of first and second dorsal fins blackish, remaining parts translucent and slightly blackish, respectively (in a single large specimen, both fins uniform dense black); pectoral fin dense black; pectoral filaments white; pelvic fin white; base of anal fin slightly yellowish, other parts white (in a single large specimen, pelvic fin uniformly black); base and posterior margin of caudal fin yellowish and dense black, respectively, other parts blackish.

Color of preserved specimens.—Based on neotype (ASIZP 60745, 152 mm SL): head and body brown dorsally, pale yellowish-silver ventrally; anterior margins of first and second dorsal fins dense black, other parts with scattered melanophores; pectoral fin dense black; pectoral filaments white; pelvic and anal fins translucent; upper, lower, and posterior margins of caudal fin dense black, other parts grayish-black.

Distribution. *Eleutheronema rhadinum* is currently known only from East Asia (China and Japan), being endemic to the area (Fig. 3).

Remarks. *Polydactylus rhadinus* was described by Jordan and Evermann (1902) from Taiwan, China, on the

Table 1. Counts and measurements of the neotype of *Polydactylus rhadinus* and non-type specimens of *Eleutheronema rhadinum*, expressed as percentages of standard length

	Neotype of *Polydactylus rhadinus* ASIZP 60745	Non-type specimens of *Eleutheronema rhadinum* $n = 18$
Standard length (mm)	152	82–739
Counts		
Dorsal fin rays	VIII-I, 14	VIII-I, 13–15
Anal fin rays	III, 15	III, 14–16 (usually 15)
Pectoral fin rays	17	17–19
Pectoral filaments	4	4
Pelvic fin rays	I, 5	I, 5
Pored lateral line scales	95	82–95
Scales above/below lateral line	12/16	11–14/15–17
Gill rakers	6 + 7 = 13	5–8 + 5–9 = 10–17
Measurements (means)		
Head length	30	28–30 (29)
Body depth	26	23–26 (24)
Second body depth	26	24–27 (25)
Body width	12	10–15 (13)
Snout length	5	4–5 (4)
Dermal eye opening	6	5–6 (6)
Orbit diameter	7	6–7 (7)
Interorbital width	7	6–7 (6)
Postorbital length	20	19–20 (19)
Upper jaw length	16	15–16 (16)
Depth of maxilla	3	3 (3)
Length of tooth plate	8	8–9 (8)
Pre-1st dorsal fin length	36	34–36 (35)
Pre-2nd dorsal fin length	63	59–63 (61)
Preanal fin length	58	58–63 (60)
Origin of 1st dorsal fin to origin of anal fin	37	35–38 (37)
Origin of pelvic fin to origin of anal fin	22	22–26 (24)
Base of 2nd dorsal fin	16	14–17 (15)
Base of anal fin	18	17–19 (18)
Length of longest pectoral fin ray (2nd)	21	20–22 (21)
Length of longest pectoral fin filament (3rd)	23	15–27 (21)
Base of pectoral fin	7	6–7 (7)
Length of longest pelvic fin ray (1st)	13	12–13 (13)
Length of longest 1st dorsal fin spine (4th)	18	15–18 (17)
Length of 2nd dorsal fin spine	7	7–9 (7)
Length of longest 2nd dorsal fin ray (2nd)	19	15–21 (19)
Length of longest anal fin spine (3rd)	7	6–8 (7)
Length of longest anal fin ray (2nd)	17	16–19 (17)
Caudal peduncle length	24	24–26 (25)
Caudal peduncle depth	11	10–12 (11)
Length of upper caudal fin lobe	37	32–38 (35)
Length of lower caudal fin lobe	36	29–36 (33)

Means in parentheses include neotype data

basis of a single specimen (273 mm TL) which has apparently been lost (not held in ZUMT; K. Sakamoto, personal communication). Since the original description, the species has been treated as a junior synonym of *Eleutheronema tetradactylum* (e.g., Weber and de Beaufort, 1922; Herre, 1953; Kagwade, 1970). However, *E. rhadinum* is clearly distinguished from the latter by the number of pored lateral line scales and coloration of pectoral fin membranes (see Discussion), although proportional measurements of the two species are similar. Accordingly, *E. rhadinum* is herein regarded as a valid species.

The proposal of a neotype for *Polydactylus rhadinus* is justifiable, owing to the close similarity of the former to *E. tetradactylum* and *E. tridactylum*. Accordingly, a specimen (ASIZP 60745, 152 mm SL) collected from Taiwan, China, is proposed as the neotype.

Fig. 4. *Eleutheronema tetradactylum* [neotype (NSMT-P 60912, 189 mm SL) of *Polynemus tetradactylus* Shaw, 1804], from Gariahat, Calcutta, West Bengal, India

Eleutheronema tetradactylum (Shaw, 1804)

(English name: fourfinger threadfin)
(Figs. 1, 3, 4, 6A, 7, 8A–C, 9, 10A,B, 11)

Polynemus tetradactylus Shaw, 1804: 155 [original locality: Vizagapatnam, India, based on "Maga Jellee"of Russell (1803: 67, fig. 183); type locality: Gariahat, Calcutta, India, based on a newly designated neotype; see Remarks].

Polynemus teria Hamilton, 1822: 224 (type locality: estuaries of Ganges River, India).

Polynemus coecus Macleay, 1878: 354, pl. 9, fig. 1 (type locality: Darwin, Northern Territory, Australia).

Neotype. NSMT-P 60912, 189 mm SL, Gariahat, Calcutta, West Bengal, India, 24 Mar. 2000, collected by H. Motomura and Y. Iwatsuki.

Other material. 112 specimens, 48–375 mm SL. AMNH 18402, 96 mm SL, Sumatra, Indonesia; AMNH 43394 (1 of 6 specimens), 122 mm SL, Eighty Miles Beach, 4.8 km north of Wallal Downs, Western Australia, Australia; AMS I. 9791, I. 16295-001 (2 syntypes of *Polynemus coecus* Macleay, 1878), 360–369 mm SL, Port Darwin, Northern Territory, Australia; ANSP 77017 (3), 52–73 mm SL, Yangon, Myanmar; ANSP 77273 (5), 85–120 mm SL, Medan, Sumatra, Indonesia; ANSP 122088, 105 mm SL, Karumba, Gulf of Carpentaria, Australia; BMNH 1898.12.24.23, 130 mm SL, Karachi, Pakistan; CAS 14589, 130 mm SL, Kozhikode, Kerala, India; CAS 69615, 143 mm SL, Sandakan, Sabah, Malaysia, Kalimantan; CAS 132894 (1 of 3), 129 mm SL, Kuching, Sarawak, Malaysia, Kalimantan; CSIRO A. 2998, 98 mm SL, Purari River, Gulf of Papua, Papua New Guinea; CSIRO A. 3066, 86 mm SL, Panaroa River, Gulf of Papua, Papua New Guinea; CSIRO H. 5173-01, 234 mm SL, off mouth of West Ajkwa River, Irian Jaya, Indonesia; FMNH 51570, 215 mm SL, Dewhurst Bay, Kinabatangan, Sabah, Kalimantan, Malaysia; FRLM 13203–13204 (2), 193–208 mm SL, Chon Buri, Thailand; FRLM 23412, 225 mm SL, Rumahtiga fish market, Poka, Ambon, Indonesia; FRLM 24545, 181 mm SL, Kupang, Timor, Indonesia; FSKU-P 19763 (3), 126–158 mm SL, Pinang Island, Malaysia; FSKU-P 21001–21002 (2), 121–169 mm SL, Borong, Kuala Lumpur, Malaysia; FSKU-P 21003, 48 mm SL, mouth of Linolak River, Banten Bay, Java, Indonesia; FSKU-P 21004–21006 (3), 164–182 mm SL, Kuala Kedah, Malaysia; HUMZ 38375, 38380, 38455, 38462, 38508, 38517 (6), 194–297 mm SL, Pinang Island, Malaysia; HUMZ 47088–47089, 47091, 47117 (4), 73–222 mm SL, Jakarta, Java, Indonesia; MCZ 59294, 118 mm SL, Kuwait Bay, Kuwait, Persian Gulf; MUFS 3359, 177 mm SL, Pinang Island, Malaysia; MUFS 14423–14424, 14474–14478 (7), 209–375 mm SL, Phuket Island, Thailand; MUFS 14466, 14482–14485 (5), 140–164 mm SL, Hat Yai, Thailand; MUFS 14995–14999 (5), 205–234 mm SL, Samut Songkhram, Thailand; MUFS 15038–15039 (2), 249–298 mm SL, Prachuap Khirikhan, Thailand; MUFS 15040–15046 (7), 142–173 mm SL, Hua Hin market, Thailand; MUFS 15143–15147 (5), 107–120 mm SL, Samut Prakan, Thailand; MUFS 16727–16728, 16746 (3), 184–224 mm SL, Mangalore central fish market, Mangalore, Karnataka, India; MUFS 16822–16824 (3), 136–160 mm SL, Shanmugam fish market, Chennai (= Madras), Tamil Nadu, India; MUFS 17810–17812 (3), 204–279 mm SL, Gun Point, Leeders Creek, Darwin, Northern Territory, Australia; MUFS 18616, 18677–18678 (3), 139–155 mm SL, Makassar (= Ujung Pandang), Sulawesi Island, Indonesia; MUFS 19054, 19056, 19134–19137, 19158 (7), 84–191 mm SL, Gariahat, Calcutta, West Bengal, India; NSMT-P 21721 (2), 134–143 mm SL, Iloilo, Panay Island, Philippines; QM I. 1300, 311 mm SL, mouth of Burnett River, Queensland, Australia; QM I. 4570, 158 mm SL, Townsville, Queensland, Australia; QM I. 21172 (3), 111–136 mm SL, Gladstone, Queensland, Australia; QM I. 25152, 150 mm SL, mouth of Arthurs Creek, Gulf of Carpentaria, Queensland, Australia; QM I. 29649, 156 mm SL, Nypa Palm Swamp, Sangatta River, Kalimantan, Indonesia; URM-P 14017, 27268 (2), 62–64 mm SL, Ban Pak Nam, Thailand; USNM 72738, 140 mm SL, Jakarta, Java, Indonesia; USNM 113205, 149 mm SL, Manila, Luzon Island, Philippines; USNM 278224, 109 mm SL, Parama Island, Papua New Guinea; USNM 278459, 91 mm SL, Muar River, Johore, Malaysia; USNM 345424, 205 mm SL, off Myanmar (15°21′ N, 95°42′ E).

Diagnosis. A species of *Eleutheronema* with the following combination of characters: 4 pectoral filaments; 16–18 (mode 17, rarely 15 or 19) pectoral fin rays; 14 (rarely 13 or 15) second dorsal fin soft rays; 71–80 (mode 73) pored lateral line scales; 9–12 (10) scale rows above lateral line, 13–15 (14) below; 3–8 (6) upper series gill rakers, 3–10 (7) lower, 6–18 (13) total; vomer with deciduous tooth plates on both sides, except in juveniles (less than ca. 70 mm SL); posterior portion of maxilla deep [mean 3% (range 3–4%) of SL]; short tooth plate extension onto lateral surface of lower jaw [8% (7–9%) of SL]; pectoral fin membranes vivid yellow in life, except in large specimens (over ca. 350 mm SL).

Table 2. Counts and measurements of the neotype of *Polynemus tetradactylus*, syntypes of *Polynemus coecus*, and non-type specimens of *Eleutheronema tetradactylum*, expressed as percentages of standard length

	Neotype of *Polynemus tetradactylus* NSMT-P 60912	Syntypes of *Polynemus coecus* $n = 2$	Non-type specimens of *Eleutheronema tetradactylum* $n = 110$
Standard length (mm)	189	360–369	48–375
Counts			
Dorsal fin rays	VIII-I, 14	VIII-I, 14	VIII-I, 13–15
Anal fin rays	III, 16	III, 15	III, 14–16 (usually 15)
Pectoral fin rays	16	17	15–19
Pectoral filaments	4	4	4
Pelvic fin rays	I, 5	I, 5	I, 5
Pored lateral line scales	73	73–78	71–80
Scales above/below lateral line	10/13	9/14–15	9–12/13–15
Gill rakers	7 + 8 = 15	3 + 3–5 = 6–8	3–8 + 3–10 = 6–18
Measurements (means)			
Head length	29	29–31	28–31 (29)
Body depth	23	24–26	23–27 (25)
Second body depth	26	25–27	23–30 (26)
Body width	12	14	10–15 (12)
Snout length	5	5	4–5 (4)
Dermal eye opening	6	5	4–6 (5)
Orbit diameter	6	6	6–7 (6)
Interorbital width	6	7	5–7 (6)
Postorbital length	19	20–21	18–21 (19)
Upper jaw length	15	17	14–17 (15)
Depth of maxilla	3	3	3–4 (3)
Length of tooth plate	7	8–9	7–9 (8)
Pre-1st dorsal fin length	34	34–37	31–36 (35)
Pre-2nd dorsal fin length	60	60–62	58–62 (59)
Preanal fin length	58	59–61	55–63 (59)
Origin of 1st dorsal fin to origin of anal fin	36	38	34–38 (37)
Origin of pelvic fin to origin of anal fin	22	20–24	20–26 (23)
Base of 2nd dorsal fin	17	15–16	13–17 (15)
Base of anal fin	21	18	17–20 (19)
Length of longest pectoral fin ray (2nd)	22	21	20–23 (21)
Length of longest pectoral fin filament (3rd or 4th)	25	22	15–28 (24)
Base of pectoral fin	7	7–8	6–8 (7)
Length of longest pelvic fin ray (1st)	13	12	12–15 (13)
Length of longest 1st dorsal fin spine (3rd)	19	17–18	16–20 (18)
Length of 2nd dorsal fin spine	7	7	7–10 (9)
Length of longest 2nd dorsal fin ray (2nd)	20	18	18–23 (21)
Length of longest anal fin spine (3rd)	8	7–8	6–9 (8)
Length of longest anal fin ray (2nd)	18	16–18	15–20 (18)
Caudal peduncle length	22	24	23–26 (24)
Caudal peduncle depth	12	10–11	10–14 (12)
Length of upper caudal fin lobe	35	32	30–38 (34)
Length of lower caudal fin lobe	32	28–32	26–36 (32)

Means in parentheses include type data

Description. Counts and proportional measurements as percentages of SL of the neotype of *Polynemus tetradactylus* and other material of *Eleutheronema tetradactylum*, including the syntypes of *Polynemus coecus*, are given in Table 2. Characters given in the diagnoses of the species and genus are not repeated here. Data for the neotype are presented first, followed by other material data (if different) in parentheses.

Body oblong, compressed; maxilla covered with scales; lip on upper jaw absent; posterior margin of preopercle serrated; posterior margin of maxilla extending well beyond level of posterior margin of adipose eyelid; teeth villiform

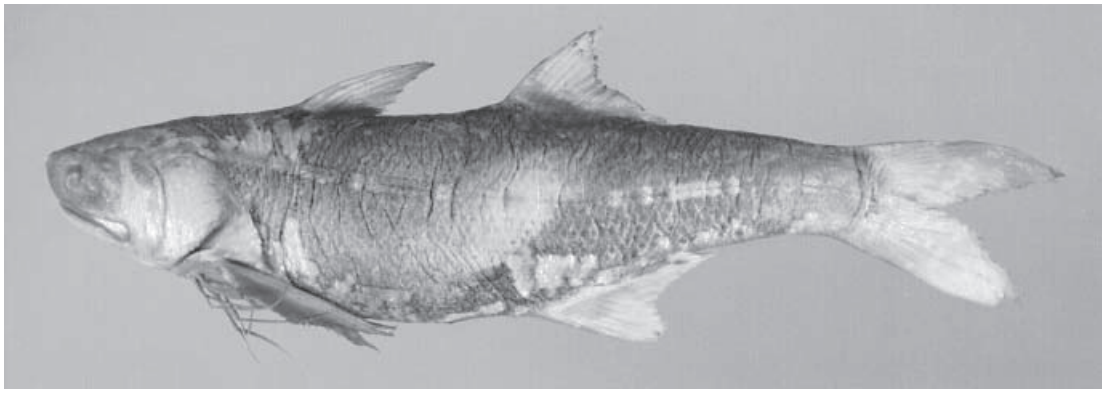

Fig. 5. *Eleutheronema tridactylum* [holotype (RMNH 6012, 255 mm SL) of *Polynemus tridactylus* Bleeker, 1845], from Jakarta, Java, Indonesia

in broad bands on vomer, palatines, and ectopterygoids; all pectoral fin rays unbranched; fourth pectoral filament longest (same or shorter than third filament), reaching to (same, not reaching or extending slightly beyond) level of posterior tip of pectoral fin; third pectoral filament (rarely longest) extending beyond level of pelvic fin origin; second pectoral filament extending slightly beyond (same or well beyond) level of pelvic fin origin; first pectoral filament shortest, not reaching to level of pelvic fin origin; posterior tip of pectoral fin just short of level of posterior tip of pelvic fin; all first dorsal fin spine bases of similar thickness (same or base of second spine slightly more robust than others in adults over ca. 300 mm SL); lateral line extending from upper end of gill opening, bifurcating on caudal fin base, upper branch extending to lower end of upper caudal fin lobe and lower branch secondarily bifurcating on middle of lower caudal fin lobe (same or lateral line simple, extending to upper end of lower caudal fin lobe); formula for configuration of supraneural bones, anterior neural spines, and anterior dorsal pterygiophores /0/2/1 + 1/1/1 + 1 + 1/ (same, /0/2/1 + 1/1/1 + 1 + 1/, /0/2/1 + 1/1 + 1/1/1/, or /0/0 + 2/1 + 1/1/1 + 1/1/); 5 (4 or 5) epineurals; 11 (11–14) dorsal and 11 (11–14) ventral series of caudal procurrent rays.

Color when fresh.—Based on color transparencies of MUFS 14423–14424, 14998 (209–375 mm SL, from Thailand), MUFS 16822, 19054, 19056 (136–191 mm SL, from India), MUFS 18616, 18677–18678 (139–155 mm SL, from Indonesia), and NSMT-P 60912 (neotype, 189 mm SL, from India): upper sides of head and trunk with slight darkish silver tinge, becoming lighter on lower sides; anterior margins of first and second dorsal fins blackish, remaining parts translucent and slightly blackish, respectively; pectoral fin vivid yellow (dusky yellow in specimens over ca. 350 mm SL); pectoral filaments white; anterior margin of pelvic fin yellow, other parts white; base of anal fin yellow, other parts yellowish-white; base of caudal fin yellowish, other parts blackish.

Color of preserved specimens.—Based on neotype (NSMT-P 60912, 189 mm SL): head and body brown dorsally, pale yellowish-silver ventrally; anterior margins of first and second dorsal fins slightly blackish, other parts with scattered melanophores; pectoral fin with scattered melanophores; pectoral filaments and pelvic fin white; anal fin white with a few scattered melanophores; upper, lower, and posterior margins of caudal fin black, other parts grayish-black.

Distribution. *Eleutheronema tetradactylum* is widely distributed in the Indo-West Pacific, where it ranges from the Persian Gulf to Papua New Guinea and northern Australia (Fig. 3).

Remarks. *Eleutheronema tetradactylum* was originally proposed by Shaw (1804) as *Polynemus tetradactylus* for the "Maga Jellee" of Russell (1803), whose description of the species included a figure (fig. 183), but lacked a formal scientific name and gave no indication of any type specimens.

Subsequently, Hamilton (1822) overlooked Shaw's (1804) description and described *Polynemus teria* from estuaries of the Ganges River, India, stating it to be the same species as Russell's (1803) "Maga Jellee." The description of *Polynemus teria* also failed to identify any type specimens. In fact, the present whereabouts of all of Hamilton's (1822) types, including the type of *Polynemus teria*, are unknown; they are not held in BMNH or other British or Indian museums (Hora, 1929). Because "4 pectoral filaments" were included in the original description of *Polynemus teria*, being consistent with the pectoral filament condition in *E. tetradactylum* and Hamilton (1822) also considered *P. teria* to be the same as Russell's (1803) "Maga Jellee" (= *E. tetradactylum*), *Polynemus teria* is clearly justified as a junior synonym of *E. tetradactylum*.

Polynemus coecus was described by Macleay (1878) from Darwin, Northern Territory, Australia, on the basis of 2 specimens. Examination of these syntypes (AMS I. 9791 and I. 16295-001) showed them both to be conspecific with *E. tetradactylum*. Their meristic and morphological characters are included in Table 2.

Günther (1860), Day (1876), and Weber and de Beaufort (1922) reported *Polynemus salliah* Cantor, 1838 as a junior synonym of *Polynemus tetradactylus* or *E. tetradactylum*. However, Cantor (1838) wrote only "To the genus Polynemus, I shall add a species, called by the natives Salliah, or Saccolih," not following the Principles of

Table 3. Counts and measurements of the holotype of *Polynemus tridactylus* and non-type specimens of *Eleutheronema tridactylum*, expressed as percentages of standard length

	Holotype of *Polynemus tridactylus* RMNH 6012	Non-type specimens of *Eleutheronema tridactylum* $n = 33$
Standard length (mm)	255	60–251
Counts		
Dorsal fin rays	VIII-I, 13	VIII-I, 13–14
Anal fin rays	III, 15	III, 14–15 (usually 15)
Pectoral fin rays	17	16–18
Pectoral filaments	3	3
Pelvic fin rays	I, 5	I, 5
Pored lateral line scales	75	72–79
Scales above/below lateral line	9/14	8–10/12–16
Gill rakers	2 + 3 = 5	2–4 + 2–6 = 4–10
Measurements (means)		
Head length	27	26–30 (28)
Body depth	24	22–27 (24)
Second body depth	26	23–29 (26)
Body width	13	9–14 (11)
Snout length	4	3–5 (4)
Dermal eye opening	5	5–6 (6)
Orbit diameter	7	6–7 (7)
Interorbital width	5	5–7 (6)
Postorbital length	18	17–20 (18)
Upper jaw length	15	14–16 (15)
Depth of maxilla	2	2–3 (2)
Length of tooth plate	9	9–10 (9)
Pre-1st dorsal fin length	33	31–36 (33)
Pre-2nd dorsal fin length	57	56–62 (59)
Preanal fin length	62	55–62 (58)
Origin of 1st dorsal fin to origin of anal fin	38	35–38 (37)
Origin of pelvic fin to origin of anal fin	27	21–28 (24)
Base of 2nd dorsal fin	15	14–17 (15)
Base of anal fin	19	18–21 (19)
Length of longest pectoral fin ray (2nd)	22	21–23 (22)
Length of longest pectoral fin filament (3rd)	24	21–29 (25)
Base of pectoral fin	7	7–8 (7)
Length of longest pelvic fin ray (1st)	11 (right side)	11–14 (12)
Length of longest 1st dorsal fin spine (3rd)	16 (tip broken)	15–20 (18)
Length of 2nd dorsal fin spine	7	7–11 (9)
Length of longest 2nd dorsal fin ray (2nd)	17 (tip broken)	18–24 (21)
Length of longest anal fin spine (3rd)	6	6–10 (8)
Length of longest anal fin ray (2nd)	16 (tip broken)	17–21 (19)
Caudal peduncle length	26	23–27 (26)
Caudal peduncle depth	11	11–13 (12)
Length of upper caudal fin lobe	27 (tip broken)	29–37 (34)
Length of lower caudal fin lobe	25 (tip broken)	25–33 (30)

Means in parentheses include holotype data

Binominal Nomenclature (Article 5.1, ICZN-1999). Furthermore, when Cantor's (1838) "Salliah or Saccolih" was first reported as a scientific name (*Polynemus salliah* Cantor, 1838), it was treated as a junior synonym of *Polynemus tetradactylus*, then considered to be valid. Accordingly, *Polynemus salliah* is not available under Articles 11.4 and 11.6 (ICZN-1999) (also see Motomura et al., 2001e).

The proposal of a neotype for *Polynemus tetradactylus* (for which the type material has apparently been lost; at least not held in BMNH; J. Maclaine, personal communication) is herein justified as being necessary to avoid taxonomic confusion, owing to the similarity of the species to *Eleutheronema rhadinum* and *E. tridactylum*. *Polynemus tetradactylus* was originally described on the basis of Russell's (1803) figure and description, being based on a

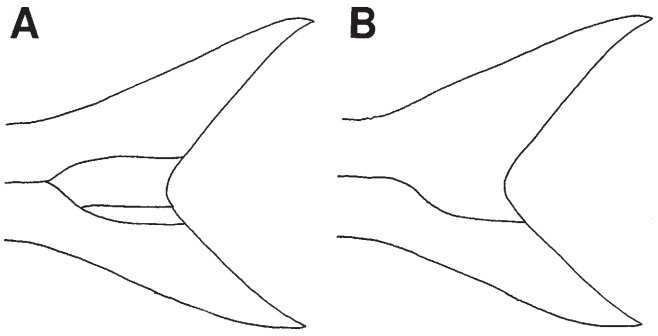

Fig. 6. Schematic illustrations of lateral line squamation on caudal fin in *Eleutheronema* species. **A** Based on neotype (NSMT-P 60912, 189 mm SL) of *Polynemus tetradactylus*. **B** Based on holotype (RMNH 6012, 255 mm SL) of *Polynemus tridactylus*

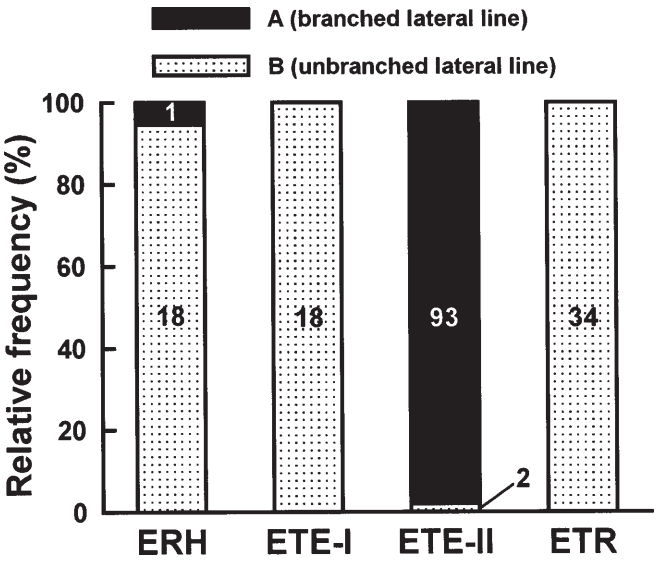

Fig. 7. Relative frequency of lateral line squamation patterns on caudal fin membrane in *Eleutheronema rhadinum* (*ERH*), *E. tetradactylum* collected from Australia and Papua New Guinea (*ETE-I*) and other localities (*ETE-II*), and *E. tridactylum* (*ETR*). *Labels* **A** and **B** correspond to **Fig. 6A** and **6B**, respectively. *Numbers* in panels indicate number of specimens examined

specimen collected from Vizagapatnam, India, Bay of Bengal. Efforts by us to collect further examples of the species from Vizagapatnam being unsuccessful, a specimen (NSMT-P 60912, 189 mm SL) collected from Calcutta, India, Bay of Bengal is herein proposed as the neotype for the species. Accordingly, Calcutta becomes the type locality of *Polynemus tetradactylus*, under Article 76.3 (ICZN-1999).

Eleutheronema tridactylum (Bleeker, 1845)

(English name: threefinger threadfin)
(Figs. 3, 5, 6B, 7, 8D,E, 9, 11)

Polynemus tridactylus Bleeker, 1845: 524 (type locality: Jakarta, Java, Indonesia).

Holotype. RMNH 6012, 255 mm SL, Jakarta, Java, Indonesia, collected by P. Bleeker.

Other material. 33 specimens, 60–251 mm SL. AMS I. 27630-016, 111 mm SL, Kuala Kurau, Malaysia; ANSP 61899 (2 specimens), 60–93 mm SL, Bangkok, Thailand; ANSP 62509, 92 mm SL, Bangkok, Thailand; ANSP 89554 (10), 110–174 mm SL, Krabi, Thailand; BMNH 1861.10.11.11, 202 mm SL, Jakarta, Java, Indonesia; BMNH 1868.6.9.13–14 (2), 120 mm SL, Sarawak, Kalimantan, Malaysia; BMNH 1880.4.21.143, 170 mm SL, Jakarta, Java, Indonesia; BMNH 1911.8.23.5, 251 mm SL, Sarawak, Kalimantan, Malaysia; CAS 50926 (2), 167–183 mm SL, ca. 20 km south of Bangkok, Thailand; CAS 161467, 105 mm SL, Surabaya, Java, Indonesia; MNHN 1977-218, 192 mm SL, Kuala Lumpur, Malaysia; RMNH 28222 (2), 130–197 mm SL, Jakarta, Java, Indonesia; RMNH 33885 (5), 140–183 mm SL, Jakarta, Java, Indonesia; UMMZ 215178, 120 mm SL, Bangkok fish market, Thailand; USNM 72737, 180 mm SL, Jakarta, Java, Indonesia; ZMH 13681, 100 mm SL, Muar River, Johore, Malaysia.

Diagnosis. A species of *Eleutheronema* with the following combination of characters: 3 pectoral filaments; 16–18 (mode 17) pectoral fin rays; 13 (rarely 14) second dorsal fin soft rays; 72–79 (mode 75) pored lateral line scales; 8–10 (9) scale rows above lateral line, 12–16 (14) below; 2–4 (3) upper series gill rakers, 2–6 (5) lower, 4–10 (8) total; vomer lacking deciduous tooth plates on both sides throughout life; posterior portion of maxilla shallow [mean 2% (range 2–3%) of SL]; long tooth plate extension onto lateral surface of lower jaw [9% (9–10%) of SL].

Description. Counts and proportional measurements as percentages of SL of the holotype of *Polynemus tridactylus* and other material of *Eleutheronema tridactylum* are given in Table 3. Characters given in the diagnoses of the species and genus are not repeated here. Data for the holotype are presented first, followed by other material data (if different) in parentheses.

Body oblong, compressed; maxilla covered with scales; lip on upper jaw absent; posterior margin of preopercle serrated; posterior margin of maxilla extending well beyond level of posterior margin of adipose eyelid; teeth villiform in broad bands on vomer, palatines, and ectopterygoids; all pectoral fin rays unbranched; third pectoral filament longest, not reaching to level of posterior tip of pectoral fin; second pectoral filament extending well beyond level of pelvic fin origin; first pectoral filament shortest, reaching to (same or extending slightly beyond) level of pelvic fin origin; posterior tip of pectoral fin just short of level of posterior tip of pelvic fin; all first dorsal fin spine bases of similar thickness; lateral line simple, extending from upper end of gill opening to upper end of lower caudal fin lobe; formula for configuration of supraneural bones, anterior neural spines, and anterior dorsal pterygiophores /0/2/1 + 1/1/1 + 1/1/ (same, //2/1 + 1/1/1 + 1 + 1/, /0/2/1 + 1/1 + 1/1/1/, or /0/0 + 2/1 + 1/1/1 + 1/1/); 5 (5 or 6) epineurals; 13 dorsal and 13 (12 or 13) ventral series of caudal procurrent rays.

Color when fresh.—Unknown.

Color of preserved specimens.—Based on holotype (RMNH 6012, 255 mm SL): head and body brown dorsally,

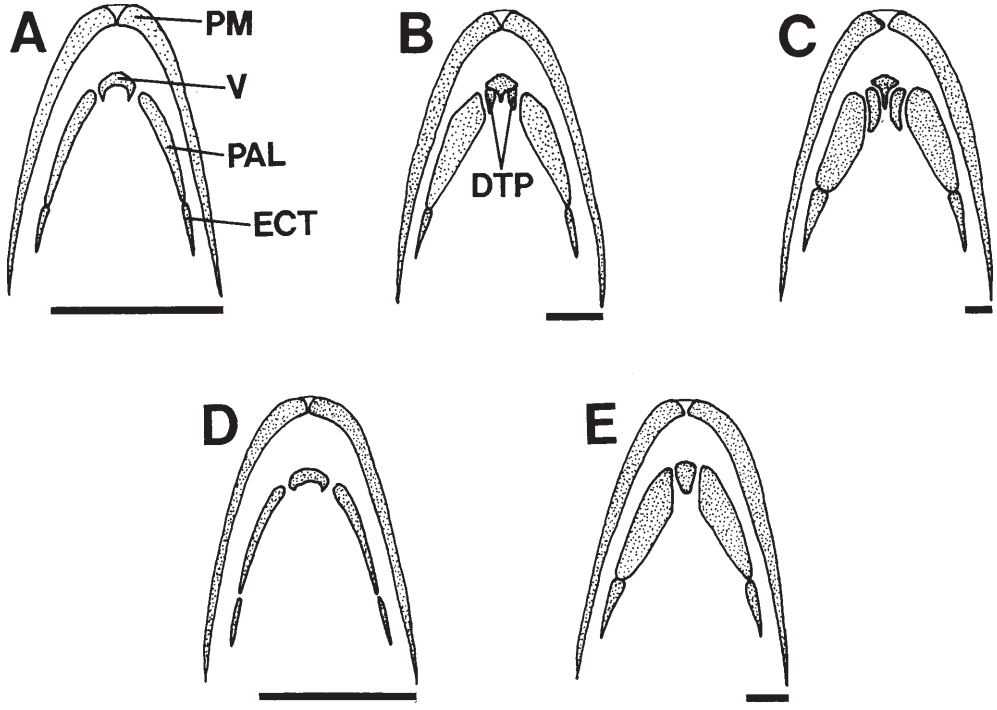

Fig. 8. Ventral view of dentition of premaxilla and roof of oral cavity of *Eleutheronema tetradactylum* (**A–C**) and *E. tridactylum* (**D,E**). **A** URM-P 27268, 64 mm SL. **B** NSMT-P 60912 (neotype), 189 mm SL. **C** MUFS 14423, 375 mm SL. **D** ANSP 61899, 60 mm SL. **E** RMNH 6012 (holotype), 255 mm SL. *DTP*, deciduous tooth plate; *ECT*, ectopterygoid; *PAL*, palatine; *PM*, premaxilla; *V*, vomer. *Small dots* indicate villiform teeth. *Bars* 5 mm

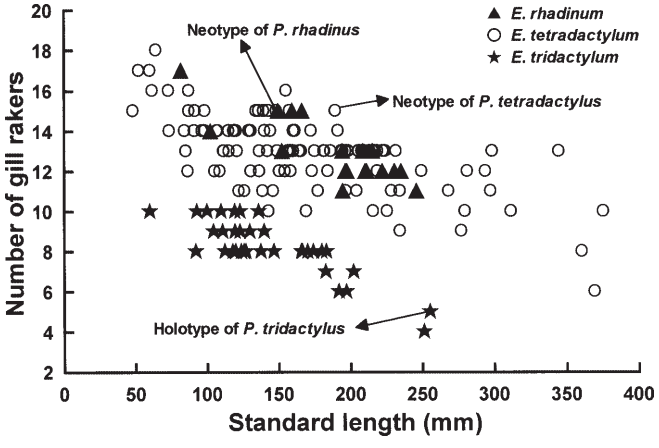

Fig. 9. Relationship between standard length and number of gill rakers in *Eleutheronema rhadinum* (*triangles*), *E. tetradactylum* (*circles*), and *E. tridactylum* (*stars*). The largest specimen (MUFS 18880, 739 mm SL) of *E. rhadinum* examined is omitted

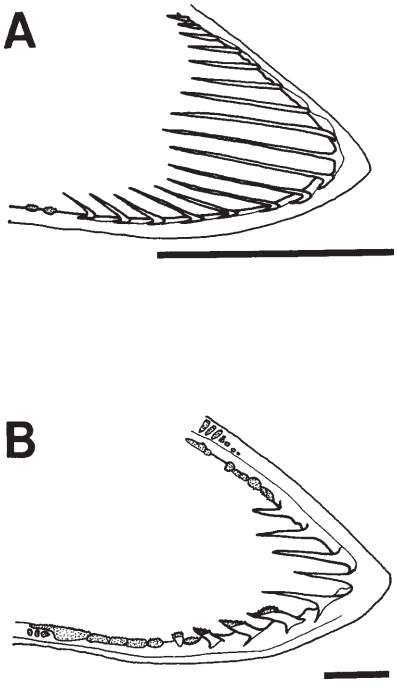

Fig. 10. Left lateral view of first gill arch of left side of *Eleutheronema tetradactylum*. **A** URM-P 27268, 64 mm SL. **B** FRLM 23412, 225 mm SL. *Small dots* indicate villiform teeth. Gill filaments not illustrated. *Bars* 5 mm

silver ventrally; all fins, including pectoral filaments, uniform brown.

Distribution. *Eleutheronema tridactylum* is currently known only from Thailand (either side of Gulf of Thailand and Andaman Sea), Malaysia (Malay Peninsula and Kalimantan), and western Indonesia (Java) (see Fig. 3), but is probably more widely distributed in western Indonesia (Sumatra and Kalimantan).

Remarks. Initially, Bleeker (1845) gave only the name "*Polynemus tridactylus*," there being no distinguishing features included. However, the species was later described in detail by Bleeker (1849) on the basis of a single specimen, 354 mm TL. Subsequently, Hubrecht (1879) referred to a total of 11 Bleeker specimens as *Eleutheronema tridactylus* (group A, 7 specimens; group B, 1 specimen; group C, 1 specimen; group D, 1 specimen; group E, 1 specimen). Two

lots, including 6 and 2 Bleeker specimens, respectively, are presently held at RMNH, registered as RMNH 6012 [138 mm SL (181 mm TL), 140 mm SL (185 mm TL), 147 mm SL (193 mm TL), 166 mm SL (218 mm TL), 183 mm SL (244 mm TL), and 255 mm SL (caudal fin broken but ca. 350 mm TL)] and RMNH 28222 [130 mm SL (caudal fin broken but ca. 175 mm TL) and 197 mm SL (253 mm TL)], respectively. Although the caudal fin was broken in the largest specimen of RMNH 6012, the original total length of that specimen was estimated from the measurements of 29 undamaged specimens (92–251 mm SL) of *E. tridactylum* examined during this study, the total length being 1.37 times the standard length. Accordingly, the total length (ca. 350 mm TL) estimated here for the largest specimen (included in RMNH 6012) is closest to that (354 mm TL) given by Bleeker, being the basis for our recognition of that specimen as the holotype of *Polynemus tridactylus*. The remaining 5 specimens in RMNH 6012 and those in RMNH 28222 are now recognized as non-type Bleeker specimens, the former having been reregistered as RMNH 33885.

Discussion

Morphological variation. Two patterns of lateral line squamation on the caudal fin membrane exist in *Eleutheronema* species (see Fig. 6). The lateral line of *E. tridactylum* is unbranched, extending from the upper end of the gill opening to the upper end of the lower caudal fin lobe (Fig. 6B), whereas it is either branched (Fig. 6A) or unbranched (Fig. 6B) in *E. rhadinum* and *E. tetradactylum*. All specimens of *E. rhadinum* examined during this study had the lateral line unbranched, except for a single specimen (Fig. 7). Similarly, all specimens of *E. tetradactylum* collected from northern and eastern Australia and from southern Papua New Guinea also had an unbranched lateral line, whereas all specimens (except 2) of that species from other localities had the lateral line divided into 3 lines on the caudal fin membrane (Fig. 7). In *E. tetradactylum*, although the relative frequency of specimens with an unbranched lateral line ranged from 100% (from Australia and Papua New Guinea) to 2% (from other localities) (Fig. 7), there were no other differences apparent. Accordingly, the differences in lateral line squamation are believed to represent intraspecific (geographic) variation. A single example with the lateral line divided into 4 lines on the caudal fin membrane was observed by the first author at Mangalore central fish market in Mangalore, Karnataka, India, but the specimen was not retained because of its large size (ca. 1.5 m SL). The existence of 3 or 4 (the latter a malformation?) branches of the lateral line on the caudal fin membrane of some *E. tetradactylum* is unique among the family Polynemidae, although bifurcation of the lateral line on the caudal fin base is known in some *Polydactylus* species, e.g., *Polydactylus approximans* (Lay and Bennett, 1839), *Polydactylus bifurcus* Motomura, Kimura and Iwatsuki, 2001, and *Polydactylus virginicus* (Linnaeus, 1758) (Motomura et al., 2001d). Other members of the family have an unbranched lateral line, extending to the upper end of the lower caudal fin lobe (Motomura et al., 2000a,b, 2001a,c,g; Motomura and Iwatsuki, 2001a,b), the lower end of the upper caudal fin lobe (Motomura et al., 2001b) or the middistal margin of the caudal fin membrane (Motomura et al., 2000c, 2001f).

The number of the supraneural bones in *Eleutheronema* species is highly variable (0–2), such variation not occurring in other members of the family.

Morphological changes with growth. The overall body appearance of *Eleutheronema* species remains relatively consistent with their growth [to at least 739 mm SL in *E. rhadinum* (this study), ca. 1500 mm SL in *E. tetradactylum* (first author, personal observation), and 255 mm SL in *E. tridactylum* (this study)]. However, the shape of the vomer and palatines of all *Eleutheronema* species changes remarkably with growth (Fig. 8). The vomer of juvenile (less than ca. 70 mm SL) *E. tetradactylum* is crescentic (Fig. 8A). In young specimens (over ca. 70 mm SL), 2 deciduous tooth plates arise from the posterolateral margins of the primary vomer, the median part of the latter projecting posteriorly (Fig. 8B). The 2 deciduous tooth plates and ectopterygoid tooth plates become larger and wider, respectively, with continued growth (Fig. 8C). The dentition of the roof of the oral cavity in *E. rhadinum* apparently also undergoes changes similar to those in *E. tetradactylum*, although the condition of the vomer in juveniles of the former is unknown [at least the smallest specimen (AMNH 17795, 82 mm SL) examined in this study has the tooth plates on both sides of the vomer]. The vomer condition, having deciduous bilateral tooth plates, in these 2 species is unique among the family Polynemidae. On the other hand, in *E. tridactylum* the shape of the vomer in juveniles and growth-related changes of the palatines are similar to those of *E. tetradactylum*, despite the lack of deciduous tooth plates in the former at any stage (Fig. 8D,E).

In addition, the number of gill rakers tended to decrease with fish size in all the *Eleutheronema* species (Fig. 9). Such a decrease is also found in *Galeoides decadactylus* (Bloch, 1795) (see Motomura et al., 2001b: Fig. 5). However, the gill rakers on the anterior parts of both the upper and lower limbs in *Eleutheronema* species are replaced during fish growth by tooth plates with villiform teeth (Fig. 10), whereas those of *G. decadactylus* simply disappear and are not replaced by tooth plates. Furthermore, each gill raker on both the upper and lower limbs in *Eleutheronema* species becomes shorter with fish growth (Fig. 10).

Comparisons. *Eleutheronema tridactylum* is easily distinguished from both *E. rhadinum* and *E. tetradactylum* by having vomer without tooth plates [vs. vomer with 2 deciduous tooth plates (in specimens at least over ca. 70 mm SL) in the latter] and lower counts of second dorsal fin soft rays [13 (rarely 14, 1 of 34 specimens) vs. 14 (13 or 15, 3 of 19 specimens in *E. rhadinum* and 10 of 113 specimens in *E. tetradactylum*); Table 4], pectoral filaments (3 vs. 4; Table 4) and gill rakers [mode 8 (range 4–10) vs. 12 (10–17) and 13 (6–18) in *E. rhadinum* and *E. tetradactylum*, respectively; Table 6, Fig. 9]. Furthermore, *E. tridactylum* tends to have a slightly shallower posterior margin of the maxilla [mean

Table 4. Frequency comparison for counts of second dorsal fin soft rays, pectoral filaments, and pectoral fin rays in *Eleutheronema* species

		Second dorsal fin soft rays			Pectoral filaments		Pectoral fin rays				
		13	14	15	3	4	15	16	17	18	19
E. rhadinum	*n* = 19	1	16[a]	2	—	19[a]	—	—	8[a]	10	1
E. tetradactylum	*n* = 113	9	103[a]	1	—	113[a]	1	25[a]	74	12	1
E. tridactylum	*n* = 34	33[a]	1	—	34[a]	—	—	5	24[a]	5	—

[a] Includes type

Table 5. Frequency comparison for counts of pored lateral line scales and scales above/below lateral line in *Eleutheronema* species

		Pored lateral line scales																							
		71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95
E. rhadinum	*n* = 16	—	—	—	—	—	—	—	—	—	—	—	1	—	—	—	1	—	1	2	2	2	1	2	1	3[a]
E. tetradactylum	*n* = 92	12	11	29[a]	13	9	8	3	1	4	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
E. tridactylum	*n* = 27	—	2	4	4	8[a]	4	3	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

		Scales above/below lateral line													
		8	9	10	11	12	13	14	/	12	13	14	15	16	17
E. rhadinum	*n* = 11	—	—	—	2	7[a]	1	1		—	—	—	2	7[a]	2
E. tetradactylum	*n* = 84	—	18	35[a]	22	9	—	—		—	17[a]	58	9	—	—
E. tridactylum	*n* = 26	3	14[a]	9	—	—	—	—		3	6	14[a]	2	1	—

[a] Includes type

Table 6. Frequency comparison for counts of upper, lower, and total gill rakers in *Eleutheronema* species

		Upper gill rakers							Lower gill rakers								
		2	3	4	5	6	7	8	2	3	4	5	6	7	8	9	10
E. rhadinum	*n* = 19	—	—	—	9	6[a]	3	1	—	—	—	1	3	10[a]	4	1	—
E. tetradactylum	*n* = 113	—	3	7	26	61	15[a]	1	—	1	—	4	20	48	29[a]	8	3
E. tridactylum	*n* = 34	2[a]	17	15	—	—	—	—	1	3[a]	4	19	7	—	—	—	—

		Total gill rakers														
		4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
E. rhadinum	*n* = 19	—	—	—	—	—	—	1	2	7	4[a]	1	3	—	1	—
E. tetradactylum	*n* = 113	—	—	1	—	1	2	7	11	14	36	23	11[a]	4	2	1
E. tridactylum	*n* = 34	1	1[a]	2	2	15	6	7	—	—	—	—	—	—	—	—

[a] Includes type

2% (range 2–3%) of SL] and a slightly longer tooth plate on the lateral surface of the lower jaw [9% (9–10%) of SL] than *E. rhadinum* [3% and 8% (8–9%) of SL, respectively] and *E. tetradactylum* [3% (3–4%) and 8% (7–9%) of SL, respectively], although the proportional length measurements overlapped among the 3 species (Fig. 11).

Eleutheronema rhadinum is very similar to *E. tetradactylum* in overall body appearance, although the former has higher counts of pored lateral line scales [mode 95 (range 82–95) vs. 73 (71–80); Table 5], plus higher scale counts above and below the lateral line [12 (11–14) and 16 (15–17), respectively vs. 10 (9–12) and 14 (13–15), respectively; Table 5]. Furthermore, the dense black pectoral fin of *E. rhadinum* distinguishes that species from *E. tetradactylum* (vivid yellow pectoral fin in life, although dusky yellow in specimens over ca. 350 mm SL).

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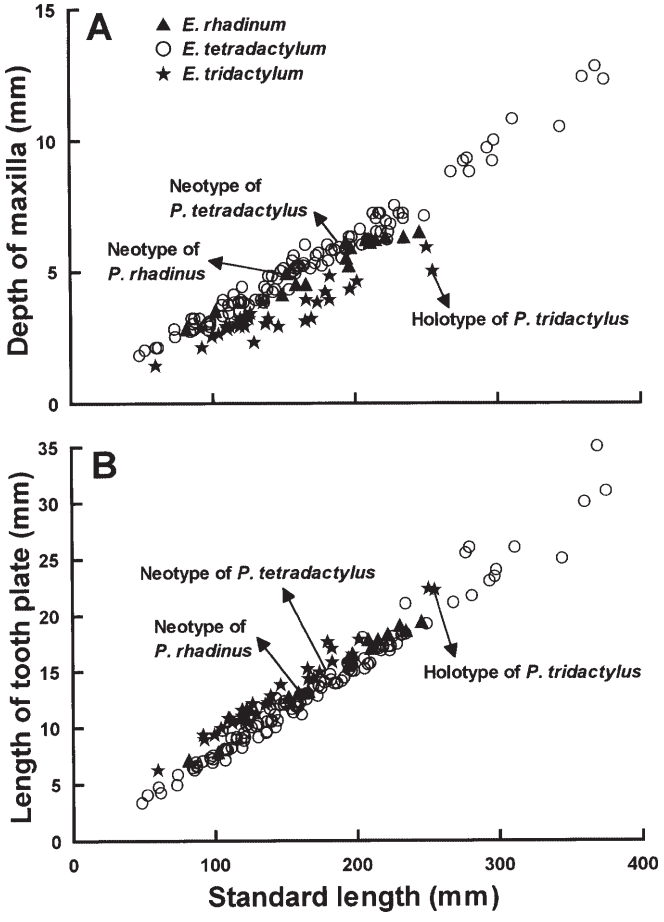

Fig. 11. Relationships of **(A)** depth of maxilla and **(B)** length of tooth plate to standard length in *Eleutheronema rhadinum* (*triangles*), *E. tetradactylum* (*circles*), and *E. tridactylum* (*stars*). The largest specimen (MUFS 18880, 739 mm SL) of *E. rhadinum* examined is omitted

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