

## Status of the eastern Pacific agujon needlefish *Tylosurus pacificus* (Steindachner, 1876) (Beloniformes: Belonidae)

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**Abstract:** *Tylosurus pacificus* (Steindachner, 1876) is confirmed to have full species rank based on: 1) sympatry with *T. acus melanotus* at Isla Gorgona and in Panamá; 2) level of morphological differentiation in numbers of vertebrae, dorsal and anal fin rays; and 3) level of mtDNA differentiation. The eastern Pacific agujon needlefish is found from the Gulf of California, Mexico, to Peru, including the Galápagos Islands.

**Key words:** Belonidae, *Tylosurus*, needlefish, eastern tropical Pacific

Two of the five recognized species of *Tylosurus* have worldwide distributions (Parin 1967, Collette and Parin 1970): *T. crocodilus* (Peron and LeSueur 1821) and *T. acus* (Lacepède 1803). *Tylosurus acus* is a slim, graceful species with many vertebrae, more dorsal and anal fin rays, and shorter dorsal and anal fin lobes, pectoral and pelvic fins compared to the heavier, stocky *T. crocodilus*. Both species have been considered polytypic with the subspecies in the eastern tropical Pacific differing from other subspecies of each species in having significantly fewer vertebrae and fin rays. For example, *T. c. crocodilus* from the western Atlantic through the Indo-West Pacific has 79-86 vertebrae compared to 67-72 in eastern Pacific *T. crocodilus fodiator* Jordan & Gilbert, 1882. Western Atlantic *T. a. acus* have 90-95 verte-

brae while eastern Pacific *T. acus pacificus* have only 74-80 vertebrae (Table 1).

The Indo-West Pacific subspecies, *T. acus melanotus* (Bleeker 1851), ranges from the Indian Ocean through the western and central Pacific Ocean to several offshore islands in the eastern Pacific: Revillagigedo, Clipperton, and Cocos (Collette 1995). This subspecies is replaced along the eastern Pacific coast of the Americas from the Gulf of California to Peru by *T. a. pacificus* (Steindachner 1876). The taxonomic status of the eastern Pacific subspecies was called into question when specimens that agreed in numbers of dorsal and anal fin-rays with the Indo-West Pacific *T. acus melanotus* were collected along with specimens with low fin-ray counts characteristic of *T. acus pacificus* at Isla Gorgona, on the Pacific coast of Colom-

bia by Franke and Acero (1992). They recommended elevating *T. acus pacificus* to species status based on their occurrence together. An anomaly that occurs occasionally only in *T. acus melanotus*, possession of a bony ventral keel on the lower jaw (Fig. 1), was the basis of a junior synonym, *T. appendiculatus* Klunzinger. A specimen with this anomaly was recently received from Panamá, also showing co-occurrence of the two “subspecies”. This paper re-appraises the taxonomic status of the eastern Pacific subspecies using meristic, morphometric, and molecular characters.

#### MATERIALS AND METHODS

Many specimens of *Tylosurus* have been examined by Collette in connection with published research (Collette and Parin, 1970) and during on-going studies of needlefishes. Material of eastern Atlantic populations was listed in Collette and Parin (1970), material of western Atlantic populations will be included in the account being prepared for inclusion in “Fishes of the western North Atlantic”. Only eastern Pacific material is listed here. Material examined is from the following institutions (abbreviations from Leviton et al., 1985): AMNH, BPBM, ANSP, CAS-SU, FMNH, LACM, MCZ, SIO, UCLA, UMMZ, and USNM.

Counts and measurements follow Collette and Parin (1970). Frequency distributions of numbers of dorsal, anal, and pectoral fin rays, and vertebrae for *Tylosurus pacificus* and populations of *T. acus* are presented.

Regression equations and other statistics were computed for 10 morphometric characters against body length for *T. pacificus* and Pacific specimens of *T. acus melanotus*. Analysis of covariance tests for differences of slopes and intercepts were performed as for Atlantic subspecies (Collette and Parin, 1970:table 15). Only F values greater than those of  $P = 0.999$  were considered significant to make this information comparable with that presented for Atlantic populations of *T. acus*.

#### *Tylosurus pacificus* (Steindachner, 1876)

*Belone pacifica* Steindachner, 1876:93 (original description, Panamá and Acapulco).

*Strongylura galapagensis* Fowler, 1944:136 (original description, Abingdon I., Galápagos Is.; holotype ANSP70251). Böhlke, 1984:27 (= *Tylosurus acus pacificus*, based on a pers. commun. from B.B. Collette).

*Tylosurus pacificus*. Meek and Hildebrand, 1923:227-228 (description, Panamá). Franke and Acero, 1992:120 (description, specimens from Isla Gorgona, specific status proposed).

*Tylosurus acus pacificus*. Collette and Berry, 1965:392 (eastern Pacific population *T. acus pacificus*). Collette and Parin, 1970:44-46 (“...the population in the eastern Pacific approaches specific distinction”). Allen and Robertson, 1994:90 (description), 93 (color pl. VI, fig. 11). Collette, 1995:925 (description, range).

*Tylosurus acus melanotus* (not of Bleeker, 1850). Grove and Lavenberg, 1997:268 (description is of *T. pacificus*).

**Diagnosis:** A species of *Tylosurus* with dorsal-fin rays 21-23 (x 21.7, Table 1); anal fin-rays 18-21 (x 19.6); pectoral fin-rays 11-14; vertebrae 74-80 (x 77.2); predorsal scales 303-405.



Fig. 1. *Tylosurus acus melanotus*, USNM 362835, Panamá City market, 675 mm Body Length, with ventral keel on lower jaw. Photograph by D. Ross Robertson.

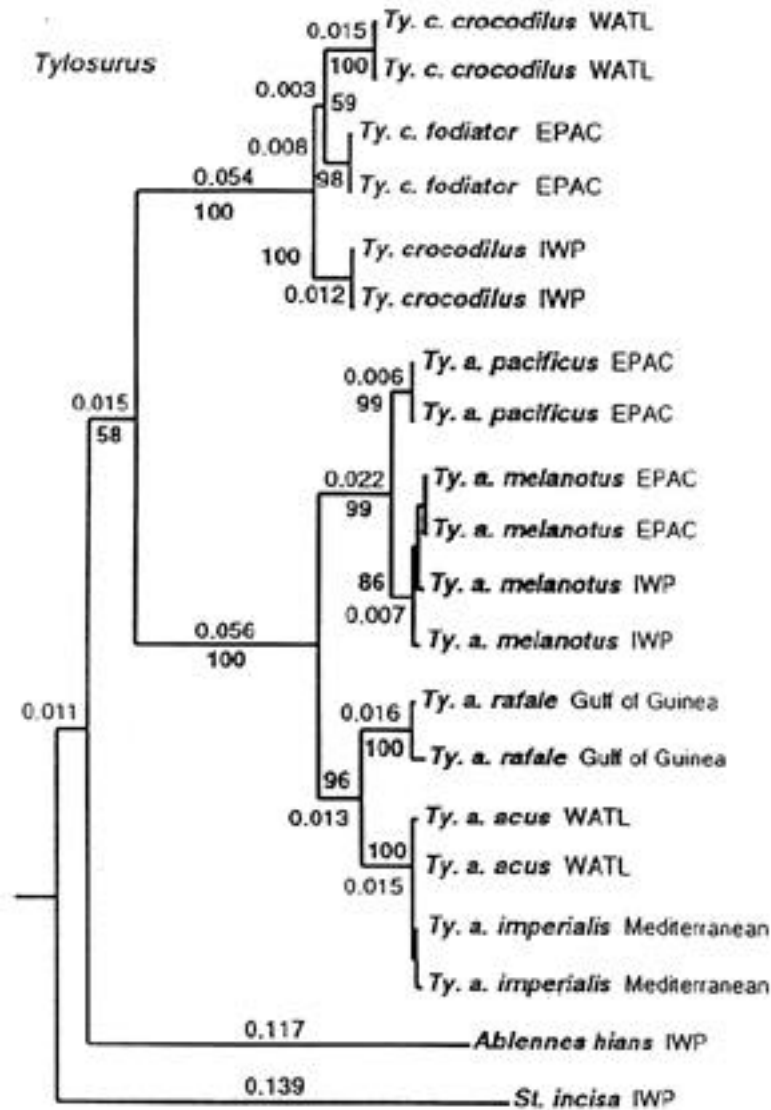


Fig. 2. Monophyletic subtree based on neighbor-joining analysis of K2p distances derived from mitochondrial ATPase8, 6 genes. Numbers in bold represent boot strap confidence estimates based on 1000 NH replications. (from Banford et al., in review:fig 3B).

**Comparisons:** *Tylosurus pacificus* is completely separated from all populations of *T. acus* in vertebral number (74-80 vs. 82-96) and from Pacific *T. acus melanotus* in numbers of dorsal (21-23, rarely 24 vs. 24-27) and anal (18-21 vs. 22-24) fin-rays. It is much less distinct morphometrically than meristically

from *T. acus melanotus*. Using the unusually high value of 0.999 as Collette and Parin (1970) did, only one of the analyses of covariance of regressions of 10 morphological characters (intercepts of orbit length) was significantly different between west-central Pacific *T. acus melanotus* and eastern Pacific

TABLE I.  
Number of dorsal and anal fin rays and vertebrae in *Tylosurus pacificus* and subspecies of *Tylosurus acus*.

Subspecies	Dorsal rays											N	
	20	21	22	23	24	25	26	27	Avg.				
<i>T. a. acus</i> - Western Atlantic			1	23	65	14	3					23.96	106
<i>T. a. imperialis</i> - Mediterranean				2	14	8	2					24.38	26
<i>T. a. rajalis</i> - Gulf of Guinea	1	7	31	27	3							22.35	69
<i>T. a. melanotus</i>													
Indian Ocean					3	20	17	2				25.43	42
W.-Cent. Pacific					4	26	12	1				25.23	43
E. Pacific					2	2	2					25.00	6
<i>T. pacificus</i> - E. Pacific		9	13	2								21.71	24

Subspecies	Anal rays											N	
	18	19	20	21	22	23	24	25	Avg.				
<i>T. a. acus</i> - Western Atlantic			4	52	49	9	1					21.37	115
<i>T. a. imperialis</i> - Mediterranean					16	8						22.33	24
<i>T. a. rajalis</i> - Gulf of Guinea		1	14	42	12							20.04	69
<i>T. a. melanotus</i>													
Indian Ocean					6	24	12					23.14	42
W.-Cent. Pacific					10	25	8					22.04	43
E. Pacific					1	2	2					22.50	6
<i>T. pacificus</i> - E. Pacific		1	9	13	2							19.64	25

Subspecies	Vertebrae																			Avg.	N					
	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92			93	94	95	96	
<i>T. a. acus</i> - Western Atlantic																									91.88	88
<i>T. a. imperialis</i> - Mediterranean																									94.19	27
<i>T. a. rajalis</i> - Gulf of Guinea																									85.90	54
<i>T. a. melanotus</i>																										
Indian Ocean																									93.43	14
W.-Cent. Pacific																									95.06	17
E. Pacific																									60.83	6
<i>T. pacificus</i> - E. Pacific		2	3	3	3	6	2	3																	77.18	22

TABLE 2.  
 Comparison of regression equations and F values based on analysis of covariance for slopes and y-intercepts of morphometric characters for *Tylosurus pacificus* and *T. aca melanotus*.  
 (\* - significant at 99% level, \*\* - significant at 99.9% level)

	Regression equations Y=		F values	
	<i>T. pacificus</i>	<i>T. a. melanotus</i>	<i>T. pacificus</i> slopes	vs. <i>T. a. melanotus</i> y-intercepts
Head depth	.0658X + 0.0061	.0803X - 4.278	9.66*	3.97
Orbit	.0397X + 1.6683	.0473X + 1.577	4.47	17.31**
Pectoral fin length	.1095X + 0.331	.1175X - 4.612	0.53	3.39
Preopercle	.0508X + 0.101	.0532X - 1.466	0.15	0.53
Interorbit	.0492X - 0.366	.0622X - 4.689	6.52	0.70
Dorsal fin lobe	.0924X - 0.689	.1055X - 2.279	1.03	1.83
Pelvic fin length	.0924X - 0.381	.0924X - 2.705	0.00	8.91*
Postorbit	.1023X - 0.039	.0965X - 0.357	1.58	11.42*
Head width	.0631X - 0.366	.0743X - 4.338	5.12	0.18
Anal fin lobe	.1092X - 1.443	.1021X - 0.637	4.22	9.57*

*T. pacificus* (Table 2). Conversely, there were 2-7 significant morphometric differences between the three Atlantic subspecies of *T. acus* (Collette and Parin, 1970:table 15).

While Banford et al. (in review) focused on relationships of American and eastern Atlantic species of the needlefish genera *Strongylura* and *Tylosurus*, we examined mtDNA from specimens of all five recognized subspecies of *Tylosurus acus* and both subspecies of *T. crocodilus*. Two major clades of *Tylosurus acus* were found, Atlantic and Indo-Pacific, with significant genetic differentiation in each major area. We defer full consideration of the systematic implications of this until a later, more comprehensive study and wish to focus on differences between *T. acus melanotus* and *T. acus pacificus* (Fig. 2). The eastern Pacific sympatric pair of *T. a. pacificus* and *T. a. melanotus* had a Kimura 2-parameter (K2p, Kimura, 1980) genetic distance of 0.018 for 1652 base pairs (bp) of the mtDNA protein-coding genes (ATPase 8,6 and cyt b); while trans-Pacific distance within *T. a. melanotus* from Panamá and Phillipines was only 0.006. The two subspecies clustered separately in phenetic (Fig. 2) and parsimony analyses.

**Size:** Maximum known size 640 mm body length (from posterior margin of opercle to caudal base), about 900 mm SL.

**Range:** Known from the Gulf of California south to Cabo Blanco, Peru including one record from the Galápagos Islands. Replaced in islands off the coast of Central America (Tres Marias Is., Revillagigedos Is., and Cocos Is.) by *T. acus melanotus*.

**Material examined.** *Tylosurus pacificus*. Forty specimens (26.8-640 mm body length) from 29 collections arranged north to south by country. **Mexico:** LACM 8802 (5, 456-550); Gulf of California, Bahia Las Palmas; R. Cannon; 19 Oct. 1959. LACM 8993-3 (1, 302); 35 mi. SW Mazatlan; S. Giacolone; Jan.-Feb. 1967. CAS-SU 14975 (1, 311); Gulf of Tehuantepec, 50 mi. SW Champauco; P. Sandez et al.; June 1943. UCLAW59-249 (1, 50.4); Gulf of California, Bahia Las Palmas; B. Walker; 17 Oct. 1959. SIO H-53-121-23A(1, 640); Baja California Sur, Bahia Almejas, 23°24.6' N, 111°43.4' W; L.D. Berner et al.; 15 July 1953. CAS uncat. (1, 115); Baja California, 26°53' N, 112°16.5' W; A.S. Loukashkin; 8

Sept. 1958. USNM 268821 (1, 577); Sonora, Choya Bay; M. Gonzalez; 1969. SIO 61-251-23A (1, 450); Gulf of California, Bahia Las Palmas, 23°38.75'N, 109°40.5'W; 19 June 1961. SIO 62-61-23A (1, 450); Isabel I., 21°52'N, 105°54'W; F.H. Berry; 24 Aug. 1961. **Guatemala:** CAS-SU 39317 (1, 296); San Geronimo. **Costa Rica:** LACM 8801 (1, 335); 6 mi. off Uvita Bay; 14 Feb. 1955. UCLA W49-463 (1, 112); 10 mi. W Quepas Point; M/V Renown; 26-27 Oct. 1949. SIO 66-82-23A(1, 120); 8°27'N, 84°27'W; Papaguero Exped.; 9 July 1965. USNM 306879 (5, 26.8-38.5); Gulf of Nicoya, Pta. Mordes; W. Szelistowski; 15 June 1989. **Panamá:** USNM 79639 (1, 430); Panamá market; S.E. Meek and S.F. Hildebrand; 17 May 1911. UCLAW51-243 (1, 90.3); Hannibel Bank; R.C. Wilson; 1 Nov. 1951. USNM 226604 (1, 76.3); Chame Point; Tweedlie. AMNH 15982 (1, 106); off Panamá; Mandel. USNM 211321 (2, 324-338); Canal Zone, Naos I.; H. Wright; 30 July 1967. CAS-SU 12806 (1, 378); Panamá; C.H. Gilbert. USNM 76822 (1, 339); Taboga I. USNM 29300 (1, 495); Panamá. USNM 200575 (1, 66.5); Chame Pt.; Tweedlie. USNM 128562 (1, 85.2); Taboga Point; S.F. Hildebrand; 31 Mar. 1957. UCLA W54-325 (1, 282); mouth of río Anton; Clemens; 28 Apr. 1954. **Colombia:** FMNH 59418 (1, 286); Tumaco; Henn and Wilson. **Ecuador:** UMMZ 191023 (1, 307); La Libertad; Velero III; 17-20 Jan. 1933. **Galápagos Islands:** ANSP 20251 (1, 241); Galápagos; 5th Vanderbilt Expedition; holotype of *Strongylura galapagensis* Fowler. **Peru:** USNM 203529-31 (3, 302-316); off Cabo Blanco, 4°14'S, 81°21'W; Bruun Cr. 15.; 12 April 1966.

*Tylosurus acus melanotus*. Seven specimens (162-675 mm body length) from four collections. **Mexico:** SIO 62-21-23A (3, 397-455); Tres Marias Is., Maria Magdalena I., 21°28'N, 106°26'W; 15 Aug. 1961. USNM 188884 (1, 382); Revillagigedos Is.; Fitch; 14 Apr. 1955. **Costa Rica:** USNM 188883 (1, 162); 50 mi. S Cabo Blanco; Clemens; 4 Apr. 1954. LACM 8796 (1, 470); Cocos Is.; 24 Oct. 1951. **Panamá:** USNM 362835 (1, 675); Panamá City fish market, D.R. Robertson, June 1999.

**Remarks:** We support Franke and Acero's (1992) suggestion to elevate *Tylosurus pacificus* to full species rank based on: 1) sympatry of both forms at Isla Gorgona and in Panamá (Fig. 1 and Banford, pers. obs.); 2) strong level of morphological differentiation in numbers of vertebrae, dorsal and anal fin rays; and 3) strong level of mtDNA differentiation. The larger question of what taxonomic rank to attribute to the other subspecies of *Tylosurus acus* will be addressed in subsequent publications.

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## RESUMEN

Se confirma que *Tylosurus pacificus* (Steindachner, 1876) tiene el rango de especie con base en su simpatría con *T. acus melanotus*, morfometría y mitocondrial.

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