Vertical Orientation in a New Gobioid Fish from New Britain

DANIEL M. COHEN[1] and WILLIAM P. DAVIS[1,2]

WHILE VISITING Rabaul, New Britain, during Cruise 6 of the Stanford University vessel "Te Vega" we observed and collected specimens of a small gobioid fish that swam and hovered vertically, with its head up, in midwater close to pockets in the wall of an underwater cliff at depths below 30 feet. Many kinds of fishes, for example scorpaenids and cottoids, are known to orient vertically in contact with a substrate. There are fewer examples of vertically oriented fishes in midwater; among the best known are the seahorses and centriscids. Observations have also been made on vertically oriented mesopelagic fishes. Barham (1966) has seen myctophids hovering vertically, as well as swimming upward and downward. Paralepidids are also known to be vertical swimmers (Pérès, 1958; Bernard, 1958; Cohen, personal observations). We have found, however, no previous record of this habit in gobioid fishes and our observations are presented herewith. We have been unable to identify the fish with any known form, and we describe it as a new species in the genus *Trimma.*

OBSERVATIONS ON LIVING ANIMALS

Dawapia Rocks (known locally as the beehive) are twin peak projections of a basaltic volcanic extrusion in the center of Simpson Harbor, Rabaul, New Britain, in the Bismarck Archipelago (H. O. Chart 2972). The largest peak in the group rises 230 feet above the water and is virtually straight-sided from the top to at least 100 feet below the surface. The extrusion arises from the harbor floor which is about 30 to 40 fathoms deep.

Vertically oriented gobioids were first observed during a SCUBA dive to about 100 feet. They were found in aggregations of 20 to 40 individuals oriented head up about 1 to 2½ feet out from the edge of the corals and crinoids covering the surface of the basaltic formation (Fig. 1). When approached, the gobies maintained their vertical orientation and retreated belly-first away from the diver. This movement is apparently accomplished by use of the pectoral and dorsal fins. No individual was observed to change its head-up attitude when retreating from a disturbance. During undisturbed vertical hovering, some fish drifted up and down, but the movement was slow and without the spurts of motion seen during retreat from disturbances. Groups of these gobies were seen along the cliff face through a depth range of 30 to 100 feet.

The group collected for identification was in a small grotto in the cliff wall. The grotto was about 8 to 12 inches deep, 3 feet high, and more or less straight-sided with an arched roof about 3 feet across. Rotenone preparation (Chem-fish Collector) was squirted into the grotto in a manner to engulf the specimens in a cloud of poison. The specimens were immediately scooped up in a collecting net and taken to the surface for special handling. Once the vertically oriented gobies were positively recognized and separated, the grotto was revisited and additional specimens were collected. In addition to the vertically swimming form, 11 other species of gobioids were taken. We identify some of them tentatively to genus (*Asterropteryx,* 1 species; *Calumia,* 1 sp.; *Eviotops,* 1 sp.; *Quisquilius,* 3 sp.; *Trimma,* 3 sp.).

Although feeding was not observed, it is likely that these gobies feed upon the resident plankters which are typically associated with reef communities (Emery, 1968). Two out of three specimens examined for stomach contents contained the remains of copepods.

As in myctophids there is no obvious external morphological specialization for the vertical swimming habit.

TAXONOMY

Notwithstanding the extensive literature on Indo-Pacific gobies and eleotrids, they represent

[1] Systematics Laboratory, Bureau of Commercial Fisheries, U S. National Museum, Washington, D. C. 20560. Manuscript received October 16, 1968.

[2] Present address: Aquatic Science Inc., 2624 N.W. 2nd Ave., Boca Raton, Florida 33432.

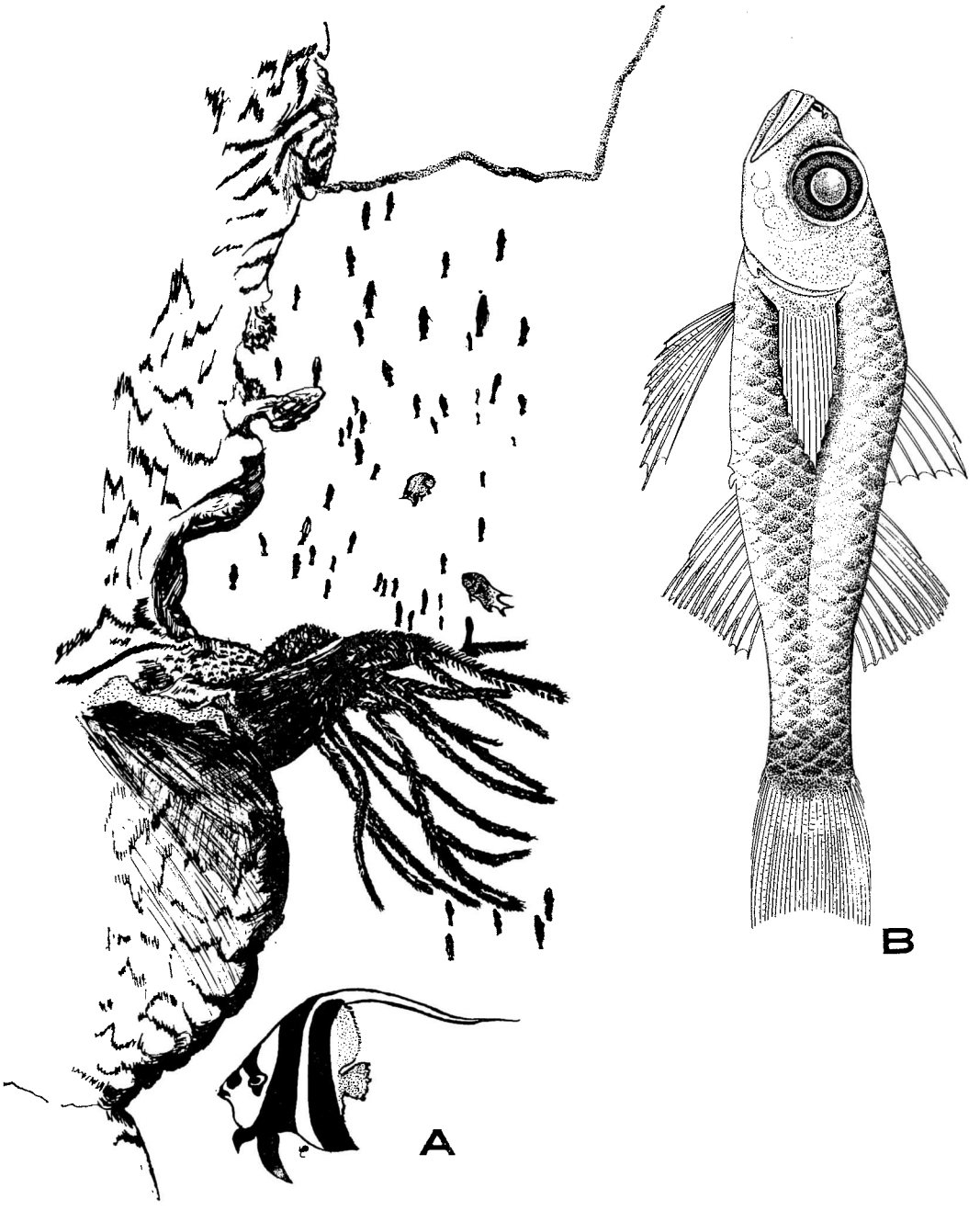

FIG. 1. *A,* Diagram of habitat of *Trimma tevegae* taken from a photograph made at Dawapia Rock, Rabaul, New Britain, at about 60 feet. *B,* Drawing of the holotype of *T. tevegae,* USNM 203436, standard length 19.8 mm. (Drawn by Mildred H. Carrington.)

a vast and poorly known assemblage of species. This situation holds especially for the many small fishes living below tidepool depth. Sampling with rotenone has revealed previously unknown kinds that differ from any known groups, and the fish described below is placed in the genus *Trimma* with some hesitation.

Genus *Trimma* Jordan and Seale, 1906

TYPE SPECIES: *Trimma caesiura* Jordan and Seale, by monotypy.

DIAGNOSIS: Spines in first dorsal fin 6, the interspace between 5 and 6 greater than the interspaces between those preceding. Ventral fin I, 5; rays not greatly branched or fringe-like. Ventral fins almost completely separate from each other, a membrane uniting them basally only; no ventral frenum. Soft rays of dorsal and anal fins branched; pectoral fin rays unbranched. Branched caudal fin rays 11. Pectoral fins lacking free rays and elongate silky pectoral rays. Caudal fin truncate or emarginate.

Lacking middorsal fleshy ridge, fleshy pad on shoulder, frenum on upper lip, and lateral line pores on head. Anterior nostrils tubular. Tongue truncate or rounded. Gape oblique. Maxillary extending below first third of eye. Head and body compressed.

Jaw teeth in narrow bands, some enlarged. No teeth on vomer or palatines.

Branchiostegal rays $1 + 4$, with the most anterior more widely separated from those following than they are from each other. The second most anterior ray projecting in a lappet of skin beyond the margin of the gill membranes. Branchiostegal membranes separate, joined to the isthmus very far forward.

Scales ctenoid on most of body, cycloid on breast. Fewer than 30 scale rows along side of body.

Vertebrae 25.

DISCUSSION: Among the studies we have consulted in attempting to identify this fish are works by Böhlke and Chaplin (1968), Fowler (1928, 1931, 1934, 1949, 1960), Gosline and Brock (1960), Herre (1927, 1936), Jordan and Seale (1906), Jordan and Snyder (1901), Koumans (1931, 1953), Munro (1967), Schultz (1943), Smith (1958, 1959, 1960) and Tomiyama (1936). Depending upon which work is used, our specimens key out or come close to *Coryphopterus, Quisquilius, Eviota, Eviotops, Amblygobius, Cingulogobius, Zonogobius, Fusigobius, Hypseleotris,* and *Trimma. Trimma caesiura* and the species described below agree with each other in the characters listed above. The same combination of characters serves to distinguish *Trimma* from the other genera noted. It is perhaps closest to *Coryphopterus* and *Quisquilius,* each of which we discuss.

Coryphopterus. We compare *Trimma* with *Coryphopterus* in the sense of Böhlke and Robins (1960*b*). The most obvious similarities are that *Coryphopterus* and *Trimma* are both small, 6-spined fishes with ctenoid scales, ventrals I, 5, teeth lacking on vomer and palatines, a tubular anterior nostril, relatively few anal and dorsal fin rays, caudal fin truncate or rounded, and a similar number of vertebrae. Also significant is the fact that *Trimma* could be placed as easily in Gobiidae as in Eleotridae because of the partial joining of the ventral fins. Böhlke and Robins (1960*a, b*) commented on this character and showed that degree of fusion of the two fins is not of generic significance. We do not disagree but merely wish to emphasize that *Trimma* resembles some of the species of *Coryphopterus* in the degree of development of this character. The most significant difference between the two genera is that *Coryphopterus* has pores on the head.

Quisquilius. As no comprehensive definition is available, we base our comparison chiefly on specimens of *Q. eugenius* Jordan and Evermann (type species of the genus). *Quisquilius* and *Trimma* resemble each other in the same ways that *Coryphopterus* and *Trimma* agree. *Quisquilius* differs from *Trimma* in having the postorbital part of the head wider than deep, more restricted gill openings, and more pronounced rows of papillae on the head.

In *Q. eugenius* the interorbit is a narrow, deep groove that branches posteriorly and continues behind the eyes to the midlevel of each orbit. When Gosline (1959) described *Q. aureoviridis* and *Q. limbatosquamis* he compared them with *Q. eugenius* and noted the absence of head grooves in his two new species. Thus by infer-

ence he discounted the generic significance of the character in *Quisquilius*. Böhlke and Robins (1960*a*) apparently agreed, as they placed *Gobius hipoliti,* a species lacking head grooves, in *Quisquilius* on the basis of a comparison with *Q. eugenius.*

Head grooves in *Trimma. Trimma caesiura* (type species of *Trimma*) has the same kind of interorbital and postorbital grooves (Fig. 2 *B,C*) described above in *Quisquilius eugenius.* Böhlke and Robins (1962) remarked on the distinctiveness of the structure in *Trimma caesiura* and interpreted it as an "open cephalic lateral line system"; Takagi (1964) also commented on it, and Smith (1956) described it in *T. naudei.* The species described below as *T. tevegae* appears to be congeneric with *T. caesiura* but lacks grooves. Among the gobioid fishes collected during "Te Vega" Cruise 6 we have found four different species of *Trimma*-like fishes with head grooves (cataloged in the U.S. National Museum as *Trimma* A, B, C, and D), though none are as pronounced as in *T. caesiura.* We have also found two species (*Trimma* E and F), in addition to *T. tevegae,* which have normal interorbitals and postorbitals.

When additional descriptive work has been done, a generic separation of the grooved and normal species of *Trimma* may be desirable. We have chosen not to do so for two reasons. First, the grooves are variously developed between species; second, the character is apparently not generically significant in the related genus *Quisquilius.*

SPECIMENS EXAMINED: *Amblygobius naraharae,* holotype, U.S. National Museum 62239. *Coryphopterus glaucofraenum* (13 specimens), USNM 203307. *Eviota abax* (25+), USNM 71405. *Coryphopterus personatus* (2), USNM 178881. *Pandaka pusilla* (9), USNM 116184. *Quisquilius aureoviridis,* holotype, USNM 175013; paratype, USNM 175014. *Q. eugenius,* syntypes (2), USNM 106537; (5), USNM 55156; (4), University of Hawaii 1702. *Q. hipoliti* (30), USNM 203308. *Q. limbatosquamis,* holotype, USNM 175012; (2), UH 3003. *Rhinogobius similis* (7), USNM 151738. *Trimma caesiura,* holotype, USNM 51772; (28), USNM 172586. *T. eviotops,* holotype, USNM 116169; paratype, USNM 116170. *Trimma* A (5), USNM 203313; (1), USNM 203319; (27), USNM 203317; (3), USNM 203316; (3), USNM 203315. *Trimma* B (8), USNM 203312; (2), USNM 203311; (1), USNM 203320. *Trimma* C (7), USNM 203309. *Trimma* D (1), USNM

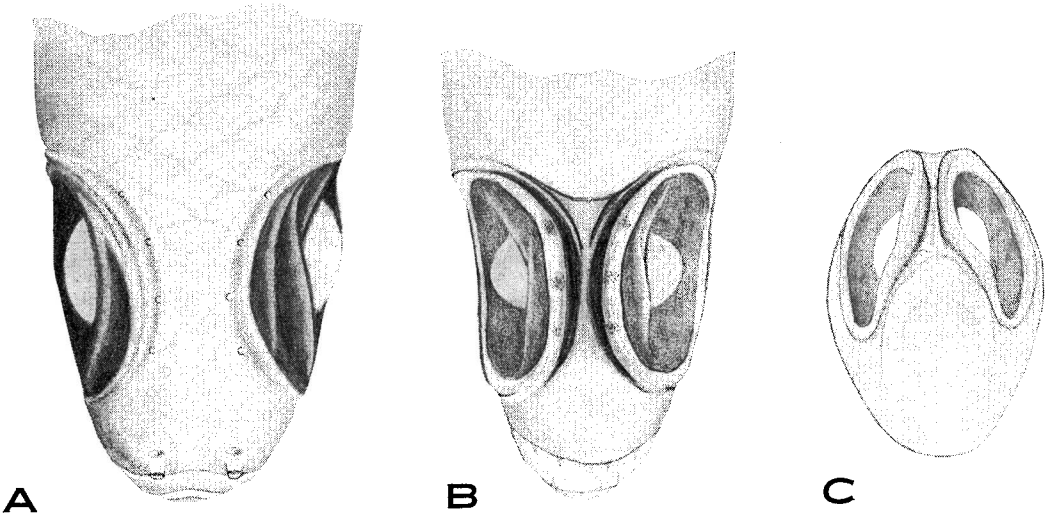

FIG. 2. *A, Trimma tevegae,* dorsal view of head, holotype, USNM 203436, standard length 19.8 mm. *B, T. caesiura,* dorsal view of head, scales not shown, USNM 51772, standard length 25.8 mm. *C,* Same specimen as *B,* anterior view of head. (Drawings by Mildred H. Carrington.)

203310. *Trimma* E (3), USNM 203314. *Trimma* F (11), USNM 203318.

Trimma tevegae sp. nov.

Figs. 1, 2*A*, 3; Table 1

DIAGNOSIS: A species of *Trimma* with a normal interorbital and postorbital, the posterior part of the caudal peduncle darkly pigmented, the ventral half of the body darker than the region above, no elongate elements in the first dorsal fin of females, and the pectoral fin rays unbranched.

DESCRIPTION: Dorsal fin formula VI–I, 9; in our single male specimen the second spine is longer than the others and when depressed extends to the origin of the second dorsal fin; in females no dorsal spine is obviously longer than any other. All soft dorsal rays except the last two are branched. Anal I, 9; all soft rays but the last two are branched. Pectoral, 13 (14 in 1), all rays unbranched, longest rays extend to level of genital region. Branched caudal rays 11; segmented caudal rays 17 (8 specimens), 16 (1), 14 (1, the smallest specimen); caudal fin truncate or slightly emarginate. Ventral fin I, 5; the fins almost completely separate, barely joined medially at their bases; no frenum (Fig. 3). Longest ventral fin rays extending to level of vent.

Scales covering entire body, cycloid on breast, otherwise ctenoid. Lateral scale rows along body 28. Predorsal scales 12, extending anteriorly to about midpoint of interorbital and laterally to upper margin of opercle. A small patch of 3 to 5 thin cycloid scales present below eye. Head otherwise naked.

Vertebrae 25, not including urostyle. Abdominal centra 10 in a single cleared and stained specimen. This character is difficult to interpret from X-ray photographs, but in 11 pictures it appears to vary from 8 to 12.

Body compressed, with greatest depth at origin of first dorsal fin, depth in standard length 4.4 (3.8 to 4.7). Head compressed, 3.4 (3.2 to 3.6) in standard length. Snout broadly rounded when viewed from above. Gape oblique; lower jaw projecting slightly. Posterior end of maxil-

TABLE 1

MEASUREMENTS OF TYPE SPECIMENS OF *Trimma tevegae* (in millimeters)

MEASUREMENT	HOLOTYPE USNM 203436		PARATYPES* USNM 203437								
	♀	♂	♀	♀	♀	♀	♀	♀	♀	♀	♀
Standard length	19.8	20.1	18.4	19.5	19.2	18.4	18.2	18.5	18.9	17.7	12.8
Preanal length	11.3	10.9	10.2	11.0	10.4	10.2	10.3	10.5	10.5	10.0	7.3
Predorsal length	7.6	7.2	7.1	7.5	7.3	6.9	6.8	7.2	6.9	7.0	5.1
Head length	5.8	5.6	5.3	5.7	5.4	5.4	5.2	5.6	5.6	5.2	4.0
Snout length	1.2	1.0	1.1	1.1	1.0	1.2	1.0	1.3	1.2	1.2	0.8
Eye diameter	2.0	2.0	1.9	2.1	2.1	1.9	1.9	2.1	2.0	1.9	1.5
Interorbital width	1.1	1.2	1.1	—	—	0.9	1.0	1.2	1.0	1.1	0.8
Greatest body depth	4.7	4.6	4.0	4.5	4.4	4.2	3.9	4.2	4.1	4.6	2.9
Pectoral fin length	4.0	3.7	4.0	4.3	3.8	4.2	3.6	3.5	3.8	3.7	2.1
Ventral fin length	4.6	5.4	4.1	4.5	4.1	4.2	3.8	4.5	4.3	4.6	2.9
Caudal fin length	3.9	3.8	3.8	4.3	4.3	3.7	4.1	3.8	3.6	4.1	2.9

* One cleared and stained paratype not included in this table.

lary below anterior third of orbit. Interorbital width (Fig. 2 *A*) equal to approximately one-half the eye diameter. Eye 2.7 (2.6 to 2.9) in head. Nostrils close to each other on a small hillock immediately behind the upper lip; anterior nostrils with thin-skinned tube.

Premaxillary with a band several teeth wide of minute, closely spaced, pointed teeth. Exterior to these is a single row of larger, more widely spaced teeth. Dentary with a narrow, irregular band of teeth resembling the larger maxillary teeth. At the projecting tip of the lower jaw a single outer row of about a dozen slightly larger, curved teeth. Description of dentition based on a single cleared and stained specimen.

Branchiostegal membranes separate from each other and joined to the isthmus very far forward if at all. Branchiostegal rays 5, the most anterior separated from the others by a space wider than the spaces between the others. The second branchiostegal ray projects in a lappet of skin beyond the margin of the branchiostegal membrane and forms one side of an indentation between the distal ends of rays two and three. Tongue broadly rounded.

Head papillae are not strongly developed. Among the most obvious are a row of small papillae above the end of the upper jaw and larger and more widely spaced papillae behind the eye and in the interorbital.

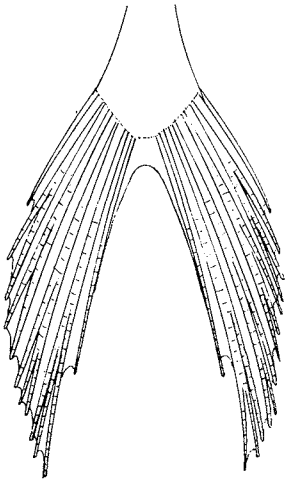

FIG. 3. *Trimma tevegae,* ventral fins, holotype, USNM 203436, standard length 19.8 mm. (Drawn by Mildred H. Carrington.)

Genital papilla of the single male elongate, flattened, and with a pointed tip. Females have a broader, more fleshy papilla with a bilobed tip.

Color in alcohol with a light straw ground color. The scale pockets are broadly edged with large brown chromatophores which are more densely distributed over the dorsum and beneath the dorsal fins. The posterior part of the caudal peduncle and the base of the caudal fin are brown. The ventral half of the side of the body has a deeper layer of larger, randomly distributed chromatophores beneath the superficial pigment of the scale pockets. The belly and most of the bottom of the head are immaculate; however, at the tip of the lower jaw there is a prominent brown triangle. Scattered chromatophores are present along the mandibles. The general body pigmentation is continued forward on the postorbital part of the head. The muzzle is dusky.

In fresh specimens the brown at the end of the caudal peduncle shows up as a dark reddish spot.

TYPES: Collected on 5 March 1965 by the authors; field number Te Vega 238. USNM numbers and sizes are given in Table 1. Type locality described above.

NAME: We take pleasure in naming this vertically swimming fish for the research vessel "Te Vega."

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