A Review of the Pacific Members of the Gobiid Fish Genus

*Bollmannia* Jordan

Robin L. Bedenbaugh
*Old Dominion University*

Follow this and additional works at: [https://digitalcommons.odu.edu/biology_etds](https://digitalcommons.odu.edu/biology_etds)

Part of the Aquaculture and Fisheries Commons, Ecology and Evolutionary Biology Commons, and the Marine Biology Commons

**Recommended Citation**

Bedenbaugh, Robin L. "A Review of the Pacific Members of the Gobiid Fish Genus *Bollmannia* Jordan" (1988). Master of Science (MS), Thesis, Biological Sciences, Old Dominion University, DOI: 10.25777/2c3j-5443

[https://digitalcommons.odu.edu/biology_etds/330](https://digitalcommons.odu.edu/biology_etds/330)

This Thesis is brought to you for free and open access by the Biological Sciences at ODU Digital Commons. It has been accepted for inclusion in Biological Sciences Theses & Dissertations by an authorized administrator of ODU Digital Commons. For more information, please contact digitalcommons@odu.edu.
A REVIEW OF THE PACIFIC MEMBERS OF
THE GOBIID FISH GENUS
BOLLMAANNIA JORDAN

by

Robin L. Bedenbaugh
B.S. May 1982, Old Dominion University

A Thesis Submitted to the Faculty of
Old Dominion University in Partial Fulfillment
of the Requirements for the Degree of

MASTER OF SCIENCE
in
BIOLOGY

OLD DOMINION UNIVERSITY
December 1988

Approved by:

Ray S. Birdsong, Director

Robert K. Rose

Alan H. Savitsky

John Holsinger
ABSTRACT

A REVIEW OF THE PACIFIC MEMBERS OF THE
GOBIID FISH GENUS BOLLMANNIA JORDAN

Robin L. Bedenbaugh
Old Dominion University, 1988
Director: Dr. Ray S. Birdsong

The Pacific members of the genus Bollmannia Jordan 1890 comprise seven species of gobies distributed from Baja California to Peru and west to the Galapagos Archipelago.

Previous authors recognized nine nominal species, all known only from their brief original accounts. Those accounts do not allow for proper discrimination of the species. All nominal species were re-examined using meristic, morphometric, and pigment-pattern characteristics. Three of the nine nominal species are herein considered synonymous with previously described forms. The six valid nominal species are redescribed, a new species is described, and a key and illustrations are provided for the seven valid species. Available distribution and ecological information is included for each species.
ACKNOWLEDGMENTS

Special thanks go to R.S. Birdsong for his guidance and support throughout the preparation of this thesis. Many thanks go to G.D. Johnson, E.O. Murdy and V.G. Springer for valuable discussion and other assistance. Thanks are also due the USNM Division of Fishes for permission to use illustrations from Ginsburg's unpublished goby manuscript.

Materials and diverse assistance have been provided by E. Anderson, S. Basnight, W. Eschmeyer, J. Holsinger, T. Iwamoto, S. Jewett, E. Lachner, C.R. Robins, R. Rose, and A. Savitzky.

I am especially grateful to my wife Karen and my cousin M.H. Kruter, without whose encouragement and support I might not have finished this project.
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>LIST OF TABLES</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>iv</td>
</tr>
<tr>
<td>LIST OF FIGURES</td>
<td>v</td>
</tr>
</tbody>
</table>

## Chapter

1. **INTRODUCTION**

   Methods .................................................................. 2

2. **BOLLMANNA JORDAN, 1890**

   Characterization of *Bollmannia* .......... 4

   Key to the Pacific Species of *Bollmannia* ........ 6

   *Bollmannia chlamydes* Jordan, 1890 ........ 8

   *Bollmannia ocellata* Gilbert, 1892 ........ 12

   *Bollmannia macropoma* Gilbert, 1892 ........ 16

   *Bollmannia stigmatura* Gilbert, 1892 ....... 19

   *Bollmannia umbrosa* Ginsburg, 1939 ....... 23

   *Bollmannia marginalis* Ginsburg, 1939 ....... 26

   *Bollmannia elongata* sp. nov. ............... 29

3. **GENERAL DISCUSSION** ........................................ 33

## BIBLIOGRAPHY .................................................. 37

## APPENDICES

A. **TABLES 1-5** ........................................... 39

B. **FIGURES 1-13** ........................................... 44
### LIST OF TABLES

<table>
<thead>
<tr>
<th>TABLE</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Frequency distribution of fin elements for the Pacific species of <em>Bollmannia</em></td>
<td>39</td>
</tr>
<tr>
<td>2. Frequency distribution of predorsal and lateral scale counts for the Pacific species of <em>Bollmannia</em></td>
<td>40</td>
</tr>
<tr>
<td>3. Lengths of upper jaw and head of the Pacific species of <em>Bollmannia</em> (in percent standard length)</td>
<td>41</td>
</tr>
<tr>
<td>4. Eye diameter of the Pacific species of <em>Bollmannia</em> (in percent standard length)</td>
<td>42</td>
</tr>
<tr>
<td>5. Greatest body depth and least caudal depth of the Pacific species of <em>Bollmannia</em> (in percent standard length)</td>
<td>43</td>
</tr>
</tbody>
</table>
**LIST OF FIGURES**

<table>
<thead>
<tr>
<th>FIGURE</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Bollmannia frenum showing frenal supports</td>
<td>44</td>
</tr>
<tr>
<td>2.</td>
<td>Dorsal and lateral views of B. ocellata head showing cephalic laterosensory pore system and sensory papillae system as illustrated for Ginsburg's unpublished MS (delineator unknown)</td>
<td>45</td>
</tr>
<tr>
<td>3.</td>
<td>Lateral view of B. stigmatura head showing cephalic laterosensory pore system and sensory papillae system as illustrated for Ginsburg's unpublished MS (delineator unknown)</td>
<td>46</td>
</tr>
<tr>
<td>4.</td>
<td>Bollmannia chlamydes, female, 73.1 mm SL</td>
<td>47</td>
</tr>
<tr>
<td>5.</td>
<td>Bollmannia ocellata, female, 83.3 mm SL</td>
<td>48</td>
</tr>
<tr>
<td>6.</td>
<td>Bollmannia pawneea (= Bollmannia ocellata) as illustrated by L. Cable for Ginsburg's unpublished MS</td>
<td>49</td>
</tr>
<tr>
<td>7.</td>
<td>Bollmannia macropoma, male, 74.1 mm SL</td>
<td>50</td>
</tr>
<tr>
<td>8.</td>
<td>Bollmannia stigmatura, male, 74.7 mm SL</td>
<td>51</td>
</tr>
<tr>
<td>9.</td>
<td>Bollmannia umbrosa, male, 69.3 mm SL</td>
<td>52</td>
</tr>
<tr>
<td>10.</td>
<td>Bollmannia umbrosa as illustrated by L. Cable for Ginsburg's unpublished MS (caudal and pectoral fins damaged)</td>
<td>53</td>
</tr>
<tr>
<td>11.</td>
<td>Bollmannia marginalis, female, 40.0 mm SL</td>
<td>54</td>
</tr>
<tr>
<td>12.</td>
<td>Bollmannia marginalis as illustrated by L. Cable for Ginsburg's unpublished MS</td>
<td>55</td>
</tr>
<tr>
<td>13.</td>
<td>Bollmannia elongata, holotype, female, 66.5 mm SL</td>
<td>56</td>
</tr>
</tbody>
</table>
The Pacific members of the genus Bollmannia comprise seven species of American seven spined gobies (tribe Gobiosomini) distributed in the eastern Pacific from Baja California to Ecuador, and west to the Galapagos Archipelago. They occur over mud or sand bottom in deep water, but the ecology of the Pacific species is otherwise virtually unknown.

The genus Bollmannia has never been treated in its entirety. It was described by monotypy when Jordan (1890) described B. chlamydes. Gilbert (1892) described three new species, B. ocellata, B. macropoma, and B. stigmatura and included a key to the four known species. Ginsburg (1939) restricted the names of two species, B. chlamydes and B. ocellata, and described four new species, B. umbrosa, B. pawneea, B. longipinnis, and B. marginalis. The last species, B. gomezi, was described by Acero (1981), bringing the number of nominal Pacific species to nine. All of the species are known only from their brief original accounts. These accounts do not allow for proper discrimination of the species as they do not follow the same descriptive format, nor are they consistent in the selection of characters used to distinguish the species. Further confusion derives from the fact that several early descriptions were based on specimens of more than one species. As a result, three of the nine nominal species are relegated to synonymy.
In this treatment, all valid species previously proposed are redescribed and are differentiated on the basis of meristic, morphometric, and pigment-pattern characteristics. A new species is described, and a key is provided to the seven valid species.

**Methods**

**Counts.** Most fin-element counts were made from radiographs of the specimens and follow Birdsong (1981: 267).

Lateral scale counts follow Birdsong (1981: 267). The scale rows are irregular anteriorly, making exact counts of scale rows difficult to obtain. The caducous nature of *Bollmannia* scales further hindered the accuracy of these counts. Predorsal scale counts were of the row of scales on the dorsal midline beginning just posterior to the orbits and ending at the origin of the first dorsal fin.

Gill raker counts refer to the rakers on both the ceratobranchial and epibranchial (lower and upper limbs) of the first branchial arch.

**Measurements.** All measurements were straightline distances taken with dial calipers to the nearest 0.1 mm, as described by Bohlke and Robins (1968: 49-50). The morphometric values are expressed in percent standard length (% SL).

The terminology of laterosensory canal and pores follows Sanzo (1911) as modified by Ginsburg (unpublished MS).
**Abbreviations.** Material was obtained on loan from a number of institutions for examination. The material examined are cited at the end of each species description. The abbreviations used in the citation of material examined follow Leviton et al. (1985).
Bollmannia Jordan, 1890: 164-165 (type species Bollmannia chlamydes Jordan by monotypy).

Characterization of Bollmannia

Bollmannia is characterized by the following combination of features, listed without reference to taxonomic importance:

The first dorsal fin comprises seven spines with their pterygiophores arranged in relation to the underlying vertebrae (starting posterior to the third neural spine) in a ratio of 2:2:1:1:1:1. Following the notation of Birdsong et al. (1988), the pterygiophore formula is 3-221110. The dorsal spines are frequently elongated into filaments in both sexes, the longest occasionally reaching beyond the base of the caudal fin.

The second dorsal fin comprises one spine and 11-15 soft rays (= 12-16 elements, Table 1). The first pterygiophore of the second dorsal is posterior to the ninth neural spine; the remaining pterygiophores are arranged in approximately a 1:1 ratio with the underlying vertebrae.

The anal fin comprises one spine and 10-15 soft rays (= 11-16 elements, Table 1). The first two anal pterygiophores lie anterior of
the first haemal spine (12th vertebra) and the remaining elements lie in an approximate 1:1 ratio with the caudal vertebrae.

The pectoral fin has 22-26 rays (Table 1).

The pelvic fins are fully united to form a disc with a well-developed frenum. Each fin comprises one spine and five rays, the medial rays being the longest. The pelvic fin frenum in *Bollmannia* is unusual in that it possesses a scalloped margin and collagenous thickenings or rays (Fig. 1). This condition appears to be unique to *Bollmannia* among the Gobiosomini (Birdsong, pers. comm.). The caudal fin is long, 0.3-0.5 times of standard length; the medial rays are longest, giving the caudal fin a distinctly lanceolate shape.

The teeth are arranged in several series in a narrow band in both jaws. The outer and inner series are usually somewhat larger than the middle series. The mouth is large and strongly inclined to the vertical. The gill openings extend the length of the pectoral base.

There are 11 precaudal and 16 caudal vertebrae including the terminal element (total vertebrae 27).

The scales are ctenoid in all species. Squamation extends over all of the body, but is greatly reduced on the head where only a few large scales appear on the opercle and cheek. There are six to ten predorsal scales (Table 2). Lateral scale rows range from 24-29 (Table 2). All species possess some medium-to-large scales on the base of the pectoral fin. Scales on all species are caducous and frequently are lost.
The genital papilla is small and conical in males, somewhat larger and bulbous in females.

The cephalic laterosensory canal system is shown in Figures 2-3. In the Pacific Bollmannia the anterior oculoscapular lateralis canal terminates at pore $\rho$ (Fig. 2) in B. chlamydes, B. ocellata, and B. marginalis and at pore $\zeta$ (Fig. 3) in B. stigmatura, B. macropoma, B. umbrosa, and B. elongata.

The sensory papillae system is extensively developed on the head (Figs. 2, 3).

Most species exhibit a large dark spot on the base of the spinous dorsal fin, the base of the caudal peduncle, or both. The sexes are not dimorphic in pigment-pattern.

The body, and to a lesser degree the head, are laterally compressed in all species.

**Key to Pacific Species of Bollmannia**

1a. Black line on upper lip; anterior oculoscapular lateralis canal terminating posteriorly at pore $\rho$ ................. 2

1b. No black line on upper lip; anterior oculoscapular lateralis canal terminating posteriorly at pore $\zeta$ ................. 5

2a. Least caudal depth less than or equal to eye diameter .......... 3

2b. Least caudal depth greater than eye diameter ................. 4
3a. Distinct spot covering base of caudal fin; lacking spot on spinous dorsal; second dorsal with 13 elements (occasionally 12 or 14) .................................. Bollmannia stigmatura Gilbert

3b. Caudal spot faint or absent; an ill-defined dark blotch on base of spinous dorsal; three to six faint dusky vertical bars on side; second dorsal with 13 elements (rarely 14) ............... ........................................ Bollmannia macropoma Gilbert

4a. Distinct spot covering base of caudal fin; lacking spot on spinous dorsal; second dorsal with 15 elements (occasionally 14 or 16) .................................. Bollmannia elongata n. sp.

4b. Caudal spot faint; a large ill-defined dark blotch at base of spinous dorsal; second dorsal with 13 elements (occasionally 12 or 14) .................................. Bollmannia umbrosa Ginsburg

5a. Lower margin or lower half of caudal fin darkly pigmented ..... 6

5b. Entire caudal fin darkly pigmented; a small ill-defined spot on base of spinous dorsal; dorsal spines little elongated; body deep .................................. Bollmannia chlamydes Jordan

6a. Entire lower half of caudal fin darkly pigmented; distinct spot on base of spinous dorsal; fourth and fifth dorsal spines elongated; occasionally reaching beyond base of caudal fin; body deep .................................. Bollmannia ocellata Gilbert
6b. Lower margin of caudal fin darkly pigmented; dark spot on margin of spinous dorsal; five or six dark mid-lateral blotches extending from behind the head to the caudal peduncle; first dorsal spine most elongate in females, fifth dorsal spine most elongate in males; body slender

\textit{Bollmannia marginalis} Ginsburg

\textbf{Bollmannia chlamydes} Jordan, 1890

(Figure 4)

\textit{Bollmannia chlamydes} Jordan, 1890: 164-165 (type locality Gulf of Panama; Lectotype USNM 93825; Paralectotypes USNM 41234, USNM 43417, CAS-SU 489).

\textbf{Diagnosis} - Second dorsal-fin elements 14 (occasionally 13); anal-fin elements 14 (occasionally 13 or 15); elements of spinous dorsal fin slightly produced as filaments; lateral scale rows 26-28; head large, 27.7-33.0; eye diameter relatively small 6.3-8.9; body and caudal peduncle deep, greatest body depth 20.0-26.7, least caudal depth 9.6-14.0; a single poorly defined dark spot on base of spinous dorsal; membrane uniting pelvic rays black; membrane uniting fin elements of all other fins, except for spinous dorsal, dark.

\textbf{Description} - Pectoral fin rays 23-26, the longest reaching beyond origin of anal fin; pelvic fin not reaching vent; medial rays of caudal
longest, approximately 0.3-0.5 times SL; posterior-most rays of second dorsal and anal fins reaching base of caudal fin when depressed; elements of spinous dorsal fin slightly produced as filaments, the longest (fifth element) only reaching the base of the sixth or seventh element of second dorsal fin when depressed.

Head length 30.7; eye diameter 7.5; upper jaw 13.7; teeth in multiple series in a narrow band in both jaws; teeth in the outer and inner series slightly larger than those of the middle series; mouth inclined about 45° from the horizontal; gill rakers on the first arch about 9+3.

Scales large, ctenoid, lateral scales increasing in size posteriad; seven or eight predorsal scales; one very large and several smaller scales on base of pectoral fin; one large and several smaller scales on upper half of opercle; several large scales on upper and lower halves of preopercle; all scales caduceus and frequently lost.

Pigmentation in preservative (Figure 4). Body uniformly brownish; a single, poorly-defined dark spot on base of first dorsal fin, covering membrane uniting the fifth, sixth, and seventh spines; branchiostegal membranes black; fin membranes of the caudal, anal, second dorsal, and pectoral fins dark; membrane of pelvic fin black; snout dusky.
Ecology - This species has been collected from depths of 12-120 m, but is taken most frequently from waters less than 40 m, over soft bottom.

Distribution - Common throughout the Gulf of Panama, but virtually unknown elsewhere, with the exception of one lot of four specimens collected in the Gulf of Guayaquil, Ecuador. This was the only lot reported from outside the Gulf of Panama.

Discussion - Jordan's description of Bollmannia chlamydes was based on many specimens from Albatross stations 2800 and 2805. Jordan originally set aside a holotype and type series, but subsequently the labels and/or specimens became confused, thus rendering the determination of the holotype impossible. In addition, Jordan's description is based on a mixture of at least two species. Ginsburg (1939) recognized this confusion, restricted the name B. chlamydes, and described a second species as B. umbrosa. At the time Ginsburg examined the material it comprised five lots bearing the type label and the catalog numbers USNM 41142, 41158, 41234, 41461, and 41489. USNM 41158 was supposedly the specimen set aside as the holotype; however, the jar contained two specimens of different species, and the label identified them as having come from Albatross station 2804. Only one of the five lots came from the type locality, Albatross station 2800. Ginsburg restricted the name B. chlamydes to this lot, USNM 41234, removing one specimen and designating it the
lectotype. It is possible that the specimen of *B. chlamydes* in USNM 41158 is the holotype, but since it cannot be shown that the station number listed on the label is erroneous, Ginsburg's lectotype, USNM 93825 (male; 74.9 mm SL), must stand. The two remaining specimens (USNM 41234, 35.7-75.2 mm SL) are paralectotypes. Since Ginsburg's restriction of the name, two additional lots from the type locality have surfaced. These lots, USNM 43417 (2; 41.5-41.8) and CAS-SU 489 (5; 34.4-78.5), though not included in Ginsburg's restriction, belong to the original type series, and are therefore valid paralectotypes. CAS-SU 489 originally consisted of nine specimens. Of those nine specimens, only five were *B. chlamydes*. The other four specimens were *B. umbrosa* and those were removed and now bear the designation CAS-SU 69105.

**Material examined (n=108) - Gulf of Panama:** USNM 93825, lectotype (male; 74.9 mm SL), Albatross Sta. 2800; USNM 41234, paralectotypes (2; 35.7-75.2), Albatross Sta. 2800; USNM 43417, paralectotypes (2; 41.5-41.8), Albatross Sta. 2800; CAS-SU 489, paralectotypes (5; 34.4-78.5), Albatross Sta. 2805; USNM 41158 (1; 80.1), Albatross Sta. 2804; USNM 41142 (1; 85.7) Panama Bay; USNM 41463 (6; 33.3-61.0), Albatross Sta. 2803; USNM 41489 (1; 73.6), Albatross Sta. 2801; USNM 244033 (2; 26.6-67.1); USNM Uncat. (2; 44.9-47.8) Ft. Amador, Panama Canal dredge effluent, 16 March 1967; SIO 71-57 (6; 82.0-86.1); SIO 71-228 (4; 63.4-74.5); UMML uncat. (29; 52.1-68.1), Sta. P-484, 1 May 1967; UMML uncat. (1; 68.7), Sta. P-485, 1 May 1967; UMML uncat. (5; 64.7-76.1),
Sta. P-488, 1-2 May 1967; UMML uncat. (32; 38.3-83.4), Sta. P-491, 2 May 1967; UMML uncat. (2; 51.5-61.0), Sta. P-493, 2 May 1967; UMML uncat. (2; 56.6-66.0), Sta. P-544, 7 May 1967.

Ecuador: USNM uncat. (4; 72.6-82.8), Anton Bruun Cr. 18B, Sta. 772, Field No. LK 66-123, Gulf of Guayaquil, 11 Sept. 1966.

**Bollmannia ocellata** Gilbert, 1892

(Figures 5, 6)

*Bollmannia ocellata* Gilbert, 1892: 555-556 (type locality Gulf of California; Lectotype USNM 107286; Paralectotypes USNM 46695, CAS-SU 76).

*Bollmannia pawneea* Ginsburg 1939: 60 (type locality Perlas Islands, Panama Bay; Holotype YPM 1689).

*Bollmannia longipinnis* Ginsburg 1939: 60 (type locality Angeles Bay, Gulf of California; Holotype YPM 1690).

**Diagnosis** — Second dorsal-fin elements 14 (occasionally 13); anal-fin elements 14 (rarely 13 or 15); fourth and fifth elements of spinous dorsal fin greatly produced as filaments; lateral scale rows 24-28; head large, 25.4-31.9; eye diameter 6.9-9.9; body and caudal peduncle deep, greatest body depth 17.5-27.2, least caudal depth 9.0-13.8; dark spot on base of spinous dorsal fin surrounded by a hyaline area, forming an ocellus; entire lower half of caudal fin darkly pigmented.
Description - Pectoral fin rays 22-26, the longest reaching beyond origin of anal fin; pelvic fins reaching vent; medial rays of caudal fin longest, approximately 0.5 times SL; posterior-most rays of second dorsal and anal fins reaching beyond base of caudal fin when depressed; fourth and fifth dorsal spines greatly produced as filaments which extend to or beyond caudal fin base.

Head length 29.1; eye diameter 8.1; upper jaw 13.2; teeth arranged in multiple series in a narrow band in both jaws, teeth in the outer and inner series slightly larger than those of the middle series; mouth inclined about 45° from the horizontal; gill rakers on first arch about 9+3.

Scales large, ctenoid; lateral scales increasing in size posteriad; six to nine predorsal scales; one large and several smaller scales on base of pectoral fin; one large and several smaller scales on upper half of opercle; several medium-sized scales on upper half of preopercle and one large and one or two small scales on lower half; all scales caducus and frequently lost.

Pigmentation in preservative (Figure 5). Body uniformly brownish; a single dark spot with a hyaline margin covering membrane uniting the fifth, sixth, and seventh dorsal-fin spines at fin base; branchiostegal membranes, pelvic fin, anal fin, and lower half of caudal fin black; pectoral and dorsal fins dusky.
Ecology - This species has been collected from depths of 14-120 m. No other ecological data is reported in the literature.

Distribution - Known from Mexico, Costa Rica, Panama, Colombia, and Ecuador.

Discussion - Gilbert's type series of Bollmannia ocellata comprised "numerous specimens" from Albatross stations 3031 and 3035. Only one lot of B. ocellata from the type locality, station 3031, remains in the USNM collection. Ginsburg (1939) restricted the name B. ocellata to this lot (USNM 46695) and designated one of the largest specimens as the lectotype, a female (57.6 mm SL), now cataloged as USNM 107286. The remaining seven specimens (USNM 46695; 39.3-60.5 mm SL) are paralectotypes.

Since Ginsburg's restriction, another lot of B. ocellata from the type locality, station 3035, was found at the California Academy of Sciences. This lot of eight specimens (CAS-SU 76, 49.7-58.4 mm SL), though not included in Ginsburg's restriction, belongs to the original type series and these specimens, therefore, are also paralectotypes. Ginsburg (1939) also described two new species, Bollmannia pawneea (Fig. 6) and Bollmannia longipinnis, that were similar to B. ocellata. Ginsburg did not redescribe B. ocellata, and his descriptions and discussions of B. pawneea and B. longipinnis were brief. In these brief descriptions, Ginsburg differentiated both species primarily on minor differences in length of the produced spinous dorsal filaments.
Examination of the holotypes of *B. pawneea* and *B. longipinnis*, as well as many specimens of *B. ocellata* showed the length of fin filaments to be highly variable and, therefore, not a good diagnostic character. *Bollmannia pawneea* was additionally differentiated from *B. ocellata* by having a deeper caudal peduncle. However, a careful examination of over 100 specimens of *B. ocellata* revealed that the least caudal depth of the *B. pawneea* holotype falls well within the range exhibited by *B. ocellata*. *Bollmannia longipinnis* was differentiated from *B. pawneea* and *B. ocellata* by reduced squamation on the opercle. No such reduction was observed by me in any of the material examined. In virtually all aspects, the *B. pawneea* and *B. longipinnis* holotypes were identical to the *B. ocellata* specimens examined. As a result, *B. pawneea* Ginsburg and *B. longipinnis* Ginsburg are relegated to the synonymy of *B. ocellata* Gilbert.

**Material Examined** (n=151) - Gulf of California: USNM 107286, lectotype (female; 56.7 mm SL), Bay Adair; USNM 46695, paralectotypes (7; 39.3-60.5), Bay Adair; CAS-SU 76, paralectotypes (8; 49.7-58.4), Bay Adair; YPM 1690, *B. longipinnis* holotype (male; 77.4 mm SL), Angeles Bay, 13 May 1926, Pawnee. Panama Bay: YPM 1689, *B. pawneea* holotype (female; 65.0 mm SL), Perlas Is., 31 March 1926, Pawnee.

Mexico. Gulf of California: SIO 65-785 (1; 49.0); USNM 54803 (2; 41.2-64.2). Gulf of Tehuantepec: SIO 63-503-59 (4; 67.9-83.5); SIO 63-504-59 (3; 74.7-78.7); SIO 63-521-49 (17; 35.1-77.0). Sinaloa: SIO 59-262 (1; 64.1); SIO 65-158-59 (1; 79.9). Sonora: SIO 64-458
(1; 87.4); SIO 64-961 (1; 76.0); CAS-SU 58831 (1; 61.2). San Blas: SIO 59-270 (1; 70.3). Santa Inez Bay: CAS-SU 53135 (2; 38.1-55.0).

No collection data: SIO 65-166 (17; 79.5-86.3).

Costa Rica. Gulf of Nicoya: CAS-SU 53134 (1; 51.8).

Panama. Gulf of Panama: UMML uncat. (34; 18.6-81.9), Sta. P-535; UMML uncat. (6; 45.7-68.7), Sta. P-536; UMML uncat. (10; 36.2-83.1), Sta P-541; UMML uncat. (2; 74.1-77.0), Sta. P-544; UMML uncat. (12; 49.4-86.3), Sta. P-546.

Colombia. South of Buenaventura: USNM 257657 (2; 68.6-74.7); USNM 257665 (3; 68.6-71.7); USNM 257690 (3; 71.0-88.7). Siviru: USNM 257673 (2; 74.5-80.7).

Ecuador. North of Manta: UMML uncat. (8; 13.6-56.1), Argosy Sta. 55. Solango Island: USNM 118356 (1; 37.5).

**Bollmannia macropoma** Gilbert, 1892

(Figure 7)

*Bollmannia macropoma* Gilbert, 1892: 556 (type locality Gulf of California; Lectotype CAS-SU 81; Paralectotypes CAS-SU 69104, USNM 612, USNM 171002).

**Diagnosis** - Second dorsal-fin elements 13 (rarely 14); anal-fin elements 14 (rarely 13 or 15); elements of spinous dorsal fin slightly produced as filaments; lateral scale rows 27-28; head large, 27.3-32.5; eye diameter relatively large, 8.0-9.9; body and caudal peduncle
relatively slender, greatest body depth 18.2-21.9, least caudal depth 7.9-9.5; least caudal depth less than or equal to eye diameter; black line on upper lip; a large but ill-defined dark spot on base of spinous dorsal; sides of body with three to six faint vertical dusky bars.

**Description** - Pectoral fin rays 24-26, the longest reaching beyond origin of anal fin; pelvic fin reaching vent; medial rays of caudal fin longest, approximately 0.5 times SL; posterior-most rays of soft dorsal and anal fins reaching base of caudal fin when depressed; elements of spinous dorsal fin slightly produced as filaments, the longest (fifth element) only reaching the base of the second or third element of the second dorsal when depressed.

Head length 30.0; eye diameter 9.1; upper jaw 13.3; teeth arranged in multiple series in a narrow band in both jaws, teeth in the outer and inner series slightly larger than those of the middle series in the upper jaw; teeth relatively uniform in size in lower jaw; mouth inclined about 45° from the horizontal; gill rakers on first arch about 9+3.

Scales large, ctenoid; lateral scales increasing in size posteriad; seven to nine predorsal scales; five or six scales on base of pectoral fin; one or two medium-sized scales on upper half of opercle, several on upper half of preopercle, and one or two small scales on lower half of preopercle; all scales caducous and frequently lost.
Pigmentation in preservative (Figure 7). Body brownish, with three to six faint dusky vertical bars on sides; a large ill-defined dark blotch covering base of fifth, sixth, and seventh dorsal-fin spine membranes; spot at base of caudal fin faint or absent; branchiostegal membranes, pelvic fin, anal fin, and second dorsal fin dusky; a prominent black line on upper lip; snout dusky.

Ecology - *Bollmannia macropoma* has been collected from depths ranging from 90-255 m. This species appears generally to inhabit deeper water than other Pacific *Bollmannia* species.

Distribution - Known from Mexico, Costa Rica, and the Galapagos Islands.

Discussion - Gilbert's type series of *B. macropoma* comprised "many specimens" from Albatross station 2996. Three lots of specimens were located from station 2996; USNM 612, USNM 171002, and CAS-SU 81. A male (81.4 mm SL) from CAS-SU 81 is hereby designated as the lectotype. The remaining five specimens out of CAS-SU 81 now bear the designation CAS-SU 69104. CAS-SU 69104 (5; 76.1-81.8), USNM 612 (1; 79.0), and USNM 171002 (2; 67.1-67.2) comprise the known paralectotypes.

This species is most easily confused with *B. umbrosa*, which it closely resembles. It is primarily differentiated by the depth of caudal peduncle in relation to eye diameter. The least caudal depth of
B. macropoma is less than the eye diameter, while that of B. umbrosa is greater than the eye diameter.

Material Examined (n=17) - Gulf of California: CAS-SU 81, lectotype (male; 81.4 mm SL); CAS-SU 69104, paralectotypes (5; 76.1-81.8); USNM 612, paralectotype (1; 79.0); USNM 171002, paralectotypes (2; 67.1-67.2).

Mexico. Gulf of California: SIO 68-113 (1; 87.1).

Costa Rica. Cabo Blanco: CAS 43878 (1; 80.1). Osa Peninsula: CAS 44079 (4; 75.6-86.3). Gulf of Nicoya: CAS 44137 (1; 86.0).

Galapagos. Punta Arenas: CAS 3559 (1; 62.0).

Bollmannia stigmatura Gilbert, 1892
(Figure 8)

Bollmannia stigmatura Gilbert, 1892: 556-557 (type locality Gulf of California; Lectotype CAS-SU 10; Paralectotypes CAS-SU 69103, USNM 614).

Bollmannia gomezi Acero, 1981: 243-244 (type locality Colombia, west of Isla Gorgona; Holotype LACM 38223-1; Paratypes LACM 38223-2, UMML 33475, INVEMAR 0267).

Diagnosis - Second dorsal-fin elements 13 (rarely 12 or 14); anal-fin elements 14 (rarely 13 or 15); elements of spinous dorsal fin moderately produced as filaments; lateral scale rows 27-28; head large,
26.1-31.1; eye diameter large, 8.1-10.8; body and caudal peduncle relatively slender; greatest body depth 17.5-24.0; least caudal depth 7.3-9.9; least caudal depth not greater than eye diameter; black line on upper lip; dark spot covering base of caudal fin.

**Description** - Pectoral fin rays 22-25, the longest reaching origin of anal fins; pelvic fins reaching to or nearly to vent; medial rays of caudal fin longest, approximately 0.5 times SL; posterior rays of second dorsal and anal fins reaching base of caudal fin when depressed; elements of spinous dorsal fin moderately produced as filaments, the longest (fifth element) reaching the base of the sixth or seventh element of the second dorsal fin when depressed.

Head length 28.7; eye diameter 9.2; upper jaw 13.1; teeth arranged in several series in a narrow band in both jaws, teeth in outer series slightly larger than those of inner series; mouth inclined about 45° from the horizontal; gill rakers on first arch about 9+3.

Scales large, ctenoid; lateral scales increasing in size posteriad; seven or eight predorsal scales; six to eight medium-sized scales on base of pectoral fin; one large and several smaller scales on upper half of opercle; several medium-sized scales on upper half of preopercle and several small scales on lower half of preopercle; all scales caducous and frequently lost.

Pigmentation in preservative (Figure 8). Body uniformly brownish; a large dark spot covering base of caudal fin; branchiostegal
membranes, pelvic fin, anal fin, and second dorsal fin dusky; a prominent black line on upper lip; snout dusky.

Ecology - Bollmannia stigmatura has been collected from depths ranging from 20-150 m, over muddy bottom (where reported).

Distribution - Known from Mexico, Costa Rica, Panama and Colombia.

Discussion - Gilbert's description of B. stigmatura was based on "many specimens" from Albatross Stations 3016 and 3017; however, no type was set aside. Only two lots of B. stigmatura can be found from the type locality. From USNM 614 comprising one specimen from station 3016 and CAS-SU 10 comprising 31 specimens from station 3017, a male from CAS-SU 10 (67.2 mm SL) is hereby designated the lectotype. The remaining 30 specimens out of CAS-SU 10 are paralectotypes and now bear the designation CAS-SU 69103 (30, 42.2-69.3). The specimen in USNM 614 (male, 69.8 mm SL) is also a paralectotype. These specimens do not entirely agree with Gilbert's description of the species. The new species described later in this study closely resembles B. stigmatura and possesses some of the characters included in Gilbert's description of B. stigmatura. It is likely that his description was based on a mixture of these two species. All of the specimens from the type locality belong to one species, however, and the name B. stigmatura is hereby restricted to this form by the designation of a lectotype. A new species, B. gomezi Acero, was differentiated from B. stigmatura.
based on Gilbert's description. Acero gave as the primary difference between B. stigmatura and B. gomezi the presence of 15 second dorsal-fin elements in the former while B. gomezi possessed only 13. Examination of the type series of B. stigmatura, however, shows that all specimens possess 13 or fewer second dorsal-fin elements, rather than the 15 reported by Gilbert. In all aspects the type specimens of B. gomezi examined appear identical to the types of B. stigmatura. Therefore, B. gomezi Acero is relegated to the synonymy of B. stigmatura Gilbert.

Material examined (n=1,182) - Gulf of California: CAS-SU 10, lectotype (male; 67.2 mm SL), Albatross Sta. 3017; CAS-SU 69103, paralectotypes (30; 42.2-69.3), Albatross Sta. 3017; USNM 614, paralectotype (1; 69.8), Albatross Sta. 3017. Colombia: LACM 38223-1, B. gomezi holotype (female; 59.4); LACM 38223-2, B. gomezi paratype (male; 46.4).

Mexico. Gulf of California: SIO 68-67 (52; 42.0-75.5).
Guerrero: CAS 57358 (1; 28.0).

Costa Rica. Gulf of Nicoya: CAS 44027 (1; 78.2); CAS 44150 (1; 70.5). Punta Burica: CAS 43847 (1; 62.6).

Panama. Gulf of Panama: USNM uncat. (243; 49.3-79.0), 6°44'00"N, 77°33'30"W, Sta. No. 76C, 8 October 1967.

Colombia. Buenaventura: USNM 257664 (2; 73.6-79.3); UMML uncat. (825; 20.7-68.1), 4°00'N, 77°30'W, Argosy 26, 17 September 1961.
**Bollmannia umbrosa** Ginsburg, 1939

(Figures 9, 10)

**Bollmannia umbrosa** Ginsburg, 1939: 59 (type locality Panama Bay; Holotype USNM 107290; Paratypes USNM 107288, USNM 107289).

**Diagnosis** - Second dorsal-fin elements 13 (occasionally 12 or 14); anal-fin elements 14 (occasionally 13 or 15); elements of spinous dorsal fin slightly produced as filaments; lateral scale rows 26-28; head large, 28.0-32.2; eye diameter large, 7.0-9.5; body and caudal peduncle relatively slender; greatest body depth 17.2-24.5; least caudal depth 8.5-11.1; least caudal depth greater than eye diameter; black line on upper lip; large dark blotch at base of spinous dorsal; faint dark spot covering base of caudal fin; six to eight faint vertical dusky bars on side of body.

**Description** - Pectoral fin rays 23-25, the longest reaching beyond origin of anal fin; pelvic fins reaching to or nearly to vent, medial rays of caudal fin longest, greater than 0.3 times SL; posterior-most rays of second dorsal and anal fins just reaching base of caudal fin when depressed; elements of spinous dorsal fin slightly produced as filaments, the longest (fifth element) reaching the base of the fourth or fifth element of the second dorsal fin when depressed.

Head length 30.5; eye diameter 8.1; upper jaw 13.4; teeth arranged in several series in a narrow band in both jaws, teeth in the outer
series much larger than those of the inner series; mouth inclined about 45° from the horizontal; gill rakers on first arch about 9+3.

Scales large, ctenoid; lateral scales increasing in size posteriad; seven to nine predorsal scales; six to eight medium-sized scales on base of pectoral fin; one or two large and one or two small scales on upper half of opercle; several medium-sized scales on upper half of preopercle and one or two large and several small scales on lower half; all scales caducous and frequently lost.

Pigmentation in preservative (Figures 9, 10). Body brownish, with six to eight faint dusky vertical bars on side; a large dark blotch covering base of fifth, sixth, and seventh dorsal-fin spine membranes; an ill-defined faint dark spot at base of caudal fin; pelvic, soft dorsal, anal, and caudal fins dusky; a prominent black line on upper lip; snout dusky.

Ecology - Bollmannia umbrosa has been collected from depths ranging from 58-100 m, over soft bottom.

Distribution - Known from Mexico, Costa Rica, Panama, Colombia, and the Galapagos Islands.

Discussion - Ginsburg examined six specimens on which he based his description of B. umbrosa. All six apparently were removed from lots containing a mixture of B. chlamydes and B. umbrosa, all from Albatross
Sta. 2804. Ginsburg cited only the holotype (USNM 107290, male, 69.1 mm SL), which was removed from USNM 41395, in his description. Four other specimens of *B. umbrosa* also were removed from USNM 41395, and one specimen was removed from USNM 41158. Although Ginsburg did not specifically refer to those specimens (USNM 107289, 4, 63.4-74.0 mm SL; and USNM 107288, female, 72.5 mm SL) in his description, they are paratypes. One specimen (Fig. 10) was illustrated for Ginsburg's unpublished manuscript.

*Bollmannia umbrosa* is most easily confused with *B. macropoma*. However, it differs in several important features, of which the most notable is that the least caudal depth is greater than the eye diameter. Also, *B. umbrosa* usually possesses more vertical bars on the body, and its dorsal spines are slightly more produced as filaments. This last character is of less diagnostic value than the others because specimens are rarely obtained with the dorsal spines undamaged.

**Material examined** (n=212) - Panama Bay: USNM 107290, holotype (male; 69.1 mm SL), Albatross Sta. 2804; USNM 107289, paratypes (4; 63.4-74.0), Albatross Sta. 2804; USNM 107288, paratype (1; 72.5), Albatross Sta. 2804.

Mexico. Manzanillo: CAS 4788-4794 (7; 46.3-59.9); CAS 4807-4808 (3; 38.7-42.0); CAS 4854-4862 (10; 48.6-59.5). Sinoloa: CAS 02686 (1; 47.9); CAS 02687 (1; 51.5); SIO 59-263 (4; 59.0-68.9). Gulf of California: SIO 60-91 (52; 50.0-84.1); SIO 62-77 (6; 80.6-86.3); SIO 70-253 (108; 27.3-68.4).
Costa Rica. Gulf of Nicoya: CAS 56784 (3; 71.4-78.0).

Panama. Gulf of Panama: UMML uncat. (4; 26.5-67.3), Sta. P-500, 2 May 1967; UMML uncat. (1; 76.7), Sta. P-515, 4 May 1967; UMML uncat. (1; 72.9), Sta. P-531, 6 May 1967; USNM uncat. (2; 70.2-72.3), 8°11'N, 79°08'W, Sta. 71, 4 April 1967.

Colombia. Buenaventura: USNM 257669 (1; 71.8).

Galapagos. Port Angeles Light: CAS 4733 (1; 44.5). Santa Maria Bay: CAS 2685 (1; 69.2).

*Bollmannia marginalis* Ginsburg, 1939
(Figures 11, 12)

*Bollmannia marginalis* Ginsburg, 1939: 59 (type locality Solango Island, Ecuador; Holotype USNM 107284).

**Diagnosis** - Second dorsal-fin elements 14 (occasionally 13 or 15); anal-fin elements 14 (occasionally 13 or 15); elements of spinous dorsal fin greatly produced as filaments; the first or second elements always longest in females, the fifth element always longest in males; lateral scale rows 26-28; head large 25.3-33.1; eye diameter relatively small, 7.0-8.9; body and caudal peduncle relatively slender; greatest body depth 16.9-22.5; least caudal depth 7.8-10.4; dark spot on spinous dorsal fin located at margin of fin, not at base as in other Pacific species of *Bollmannia*; a series of dark mid-lateral blotches extending from behind head to base of caudal fin.
Description - Pectoral fin rays 23-25, the longest just reaching origin of anal fin; pelvic fins reaching vent; medial rays of caudal fin longest, approximately 0.3 times SL; posterior-most rays of second dorsal and anal fins reaching base of caudal fin when depressed; elements of spinous dorsal fin greatly produced as filaments, often reaching caudal peduncle or caudal fin base when depressed.

Head length 28.7; eye diameter 7.7; upper jaw 11.9; teeth arranged in several series in a narrow band in both jaws, teeth in outer series slightly larger than those of the inner series; mouth inclined about 45° from the horizontal; gill rakers on the first arch about 9+3.

Scales large, ctenoid; lateral scales increasing in size posteriad; seven to nine predorsal scales; one large and four or five small scales on pectoral base; one or two large scales on upper half of opercle; several medium scales on upper half of preopercle; all scales caduceus and frequently lost.

Pigmentation in preservative (Figures 11, 12). Body brownish, with five or six dark mid-lateral blotches extending from behind the head to the caudal fin base; a distinct dark spot on spinous dorsal fin, located at margin of fin; anal fin dusky with darker margin; caudal fin dusky with darker ventral margin; pelvic fins dark; second dorsal fin uniformly dusky.

Ecology - *Bollmannia marginalis* has been collected from depths ranging from 14-77 m, over soft bottom.
Distribution - Known from Mexico, Costa Rica, Panama, Colombia, and Ecuador.

Discussion - The holotype, USNM 107284 (male; 40.2 mm SL) is now broken in half. Ginsburg had this specimen illustrated for his manuscript prior to its being damaged, however, and that illustration is reproduced here (Fig. 12).

This species is most easily confused with small specimens of B. ocellata, but can be readily distinguished by the following differences. In B. marginalis only the ventral margin of the caudal and anal fins are darkly pigmented, whereas the entire lower half of the caudal fin and the entire anal fin are darkly pigmented in B. ocellata. Bollmannia marginalis possesses five or six dark mid-lateral blotches, whereas these blotches are absent in B. ocellata. Finally, the dark spot on the spinous dorsal fin is located at the margin of the fin in B. marginalis, but near the base of the fin in B. ocellata.

Bollmannia marginalis is unique among the Pacific members of the genus in exhibiting sexual dimorphism in spinous dorsal-fin structure. The first or second element of the spinous dorsal fin is always longest in females, whereas the fifth element is always longest in males. In all other Pacific species of Bollmannia, the fourth and fifth spinous dorsal-fin elements are longest in both sexes.

Material examined (n=155) - Solango Island: USNM 107284, holotype (male; 40.2 mm SL).
Mexico. CAS-SU 18902 (1; 42.2); Gulf of California: SIO 60-95 (23; 25.2-45.0).


Panama. Bahia Honda: CAS-SU 61738 (7; 17.2-24.0). CAS-SU 61749 (3; 20.1-20.5); Gulf of Panama: UMML uncat. (9; 29.9-38.4), Sta. P-493, 2 May 1967; UMML uncat. (2; 30.8-30.9), Sta. P-516, 4 May 1967; UMML uncat. (5; 18.6-37.2), Sta. P-535, 6 May 1967; UMML uncat. (2; 25.0-34.7), Sta. P-536, 6 May 1967; UMML uncat. (7; 32.5-45.4), Sta. P-546, 7 May 1967; Pinas Bay: UMML uncat. (1; 30.8), Sta. Argosy 8, 8 Sept. 1961.


**Bollmannia elongata** sp. nov.

(Figure 13)

*Bollmannia elongata* (type locality Malpelo Ridge, E. of Isla de Malpelo, Colombia; Holotype USNM 300283).

**Diagnosis** - Second dorsal-fin elements 15 (occasionally 14 or 16; anal-fin elements 15 or 16 (occasionally 14); elements of spinous
dorsal fin moderately produced as filaments; lateral scale rows 28-29; head large, 24.8-31.0; eye diameter large, 6.7-9.2; body and caudal peduncle very slender; greatest body depth 16.8-21.9; least caudal depth 7.7-9.1; least caudal depth greater than eye diameter; black line on upper lip, large dark spot covering base of caudal fin.

Description - Pectoral fin rays 24-26, the longest just reaching origin of anal fin; pelvic fin not quite reaching vent; medial rays of caudal fin longest, about 0.5 times SL; posterior-most rays of second dorsal and anal fins reaching base of caudal fin when depressed; elements of spinous dorsal fin moderately produced as filaments, extending to about middle of base of second dorsal fin when depressed.

Head length 27.3, eye diameter 7.8; upper jaw 11.6; teeth arranged in several series in a narrow band in both jaws, those in outermost series in upper jaw much larger than those of inner series; teeth in lower jaw all of relatively uniform size; mouth inclined about 45° from the horizontal; gill rakers on first arch about 9+3.

Scales large, ctenoid; lateral scales increasing in size posteriad; nine or ten predorsal scales; one large and four or five medium-sized scales on base of pectoral fin; one or two large and one or two small scales on upper half of opercle; several medium-sized scales on upper half of preopercle and one large and several small scales on lower half; scales caducous and frequently lost.
Pigmentation in preservative (Figure 13). Body brownish, somewhat darker dorsally; a large dark spot covering base of caudal fin; pelvic, soft dorsal, and anal fins dusky; a prominent black line on upper lip; snout dusky.

Ecology - _Bollmannia elongata_ is most frequently captured from depths between 65-150 m, although at least one specimen examined was taken from a depth of 13 m. As with other Pacific _Bollmannia_, it is found over soft bottom.

Distribution - Known from the Panama Basin from the Coiba Ridge region south of Panama to Ecuador.

Discussion - This species closely resembles _B. stigmatura_ and Gilbert's original account of _B. stigmatura_ appears to have been based partly upon it.

_Bollmannia elongata_ can be readily distinguished from _B. stigmatura_ by the following characters: 1) the least caudal depth is greater than the eye diameter in _B. elongata_, whereas it is less than the eye diameter in _B. stigmatura_; 2) _B. elongata_ has more numerous second dorsal-fin elements (usually 15) and anal-fin elements (usually 15 or 16) than _B. stigmatura_, which normally possesses 13 second dorsal-fin elements and 14 anal-fin elements; 3) _B. elongata_ usually possesses nine or ten predorsal scales, while _B. stigmatura_ usually possesses six to eight.
Bollmannia elongata also resembles B. umbrosa. Bollmannia elongata can be readily distinguished from B. umbrosa by the absence of a dark spot on the spinous dorsal fin and by the lack of vertical bars on the sides of the body.

Material examined (n=287) - Malpelo Ridge: USNM 300283, holotype (female; 66.5 mm SL).

Panama. Coiba Ridge: USNM 300277 (2; 54.7-75.9); USNM 300278 (1; 72.9); USNM 300276 (1; 41.8); USNM 300280 (115; 42.4-83.6); USNM 300279 (68; 54.1-77.3); USNM 300281 (1; 41.5); USNM 300282 (4; 54.6-72.9).

Colombia. Malpelo Ridge: USNM 300284 (48; 46.1-70.4); USNM 300285 (1; 66.2); USNM 300275 (7; 47.7-68.8).

GENERAL DISCUSSION

Characters used to describe the Pacific species of Bollmannia varied widely in the original accounts. Some of the diagnostic characters used in early accounts were not employed diagnostically in this review, and the exclusion of those characters deserves explanation.

In some of the original accounts fin lengths, length of produced dorsal filaments, cutaneous papillae patterns on the head, and squamation of the cheeks were used as diagnostic characters to differentiate several species. I have little doubt that these characters could aid in the differentiation of certain species if the structures were not lost or damaged. Unfortunately, the fin elements are very delicate and the scales are caducous. All of the material that I examined was collected by trawl or dredge from relatively deep water. Of the many hundreds of specimens examined, I found none with all fins undamaged or with all scales intact. It is likely that much of this damage occurs during collection. Further fin damage and scale loss frequently occurs during handling, even when considerable care is exercised. For this reason, fin lengths are given only descriptive consideration in this treatment.

Length of the produced dorsal filaments is even more difficult to ascertain. Several elements of the first dorsal fin are produced as filaments to some degree in all of the Pacific species of Bollmannia. These filaments are so delicate, however, that they rarely are found
intact in preserved material. This makes their utility as a diagnostic character questionable at best. The lengths given in this treatment are of the longest filaments observed for each species.

Ginsburg (1939) believed that the pattern of cutaneous papillae could be of value diagnostically. He partially differentiated _B. pawneea_ from _B. ocellata_ and _B. longipinnis_ by "a great profusion of cutaneous papillae." Examinations of the type specimens of _B. pawneea_, _B. ocellata_ and _B. longipinnis_ reveal that all three have such a profusion. Some specimens do appear to have a greater number of cutaneous papillae than others, but a considerable amount of intraspecific variation was observed. It was often difficult to determine whether two specimens of the same species had similar patterns of cephalic papillae. Additionally, some specimens appeared to exhibit bilateral asymmetry. There are two primary difficulties with using cutaneous papillae as diagnostic characters, and both apply to this study. First, the papillae are easily damaged and rarely can be described with accuracy in older material. Secondly, intraspecific variation of papillae pattern is poorly understood and, in older material, cannot be distinguished from differences due to damage. For these reasons, I do not find the pattern of cutaneous papillae to be diagnostic.

Squamation of the cheeks apparently can be diagnostic among some of the species of _Bollmannia_. Though the scales were often lost, it could usually be determined that scales had formerly been present; however, accurate counts or arrangements of those scales were difficult
to determine. For this reason, squamation of the cheeks was employed only descriptively.

Body depth measurements, which are considered diagnostic in this treatment, must be applied with caution. Such measurements exhibited wide ranges of intraspecific variation, much of it apparently attributable to dehydration of the specimens. Many of the specimens examined were quite old, dating back as far as the early 1890's. These specimens exhibited obvious dehydration from many years in preservative. Other material was more recent, dating from the late 1960's and early 1970's, and the body depth values cited in the descriptions are the ranges and means for all the material examined, both old and new. In general, the more recent specimens yielded less variable body depth information. When only recent material was considered, the species could be divided into more or less distinct groups, with *B. chlamydes* and *B. ocellata* displaying a deep body, *B. macropoma*, *B. stigmatura*, *B. umbrosa*, and *B. marginalis* a moderately slender body, and *B. elongata* a very slender body. Due to the effects of dehydration in older material, primary diagnostic emphasis was placed on pigmentation pattern and counts of fin elements, with cautious secondary emphasis on body depth measurements.

Pigmentation pattern served to be the most useful diagnostic tool for the Pacific species of *Bollmannia*. There is no sexual dimorphism in pigmentation pattern. Occasionally, the pigmentation of old
specimens was faded considerably, several key pigmentation characters usually remained. These key characters were the dorsal-fin spot, caudal-fin spot, and dark line on the upper lip.

Present knowledge of the distribution patterns of the Pacific species of *Bollmannia* are inadequate for zoogeographic analysis. The species range from the Gulf of California to the southern tip of Ecuador and west to the Galapagos Islands. *Bollmannia ocellata* and *B. marginalis* occur throughout that range, exclusive of the Galapagos Islands. *Bollmannia macropoma*, *B. stigmatura*, and *B. umbrosa* seem to be primarily distributed north of the equator, whereas *B. elongata* occurs primarily south of the equator. There are a few exceptions to the above generalities, but they are fair representations of the known distributions. The distribution of *B. chlamydes* is less clear. *Bollmannia chlamydes* is the most widespread and abundant species in the Gulf of Panama. Only one lot of specimens is reported from outside the Gulf of Panama, from the extreme southern coast of Ecuador. The lot of four specimens was collected during the Anton Bruun cruise 18B, which made collections in the Gulf of Panama, Colombia, Ecuador, and the Galapagos Islands. I strongly suspect that the data accompanying those specimens are in error and that *B. chlamydes* is restricted to the Gulf of Panama.
BIBLIOGRAPHY


Gilbert, C.H. 1892. Scientific results of explorations by the U.S. Fish Commission steamer Albatross No. XXII - Descriptions of thirty-four new species of fishes collected in 1888 and 1889, principally along the Santa Barbara Islands and in the Gulf of California. Proc. USNM 14: 539-566.


Table 1. Frequency distribution of fin elements for the Pacific species of Bollmannia.

<table>
<thead>
<tr>
<th>Species</th>
<th>Second Dorsal Fin</th>
<th>Anal Fin</th>
<th>Pectoral Fin</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>12    13  14  15  16</td>
<td>11  12  13  14  15  16</td>
<td>22  23  24  25  26</td>
</tr>
<tr>
<td>B. chlamydes</td>
<td>2  62  2</td>
<td>4  62</td>
<td>39  21  4  2</td>
</tr>
<tr>
<td>B. ocellata</td>
<td>7  82</td>
<td>6  79  4</td>
<td>1  31  39  15  3</td>
</tr>
<tr>
<td>B. macropoma</td>
<td>15  1</td>
<td>1  14  1</td>
<td>3  7  6</td>
</tr>
<tr>
<td>B. stigmatura</td>
<td>4  105  2</td>
<td>6  98  7</td>
<td>14  29  28  40</td>
</tr>
<tr>
<td>B. umbrosa</td>
<td>4  60   4</td>
<td>1  10  53  4</td>
<td>7  22  39</td>
</tr>
<tr>
<td>B. marginalis</td>
<td>3  13   3</td>
<td>2  12  5</td>
<td>3  8  8</td>
</tr>
<tr>
<td>B. elongata</td>
<td>18  134  9</td>
<td>6  115  40</td>
<td>16  76  69</td>
</tr>
</tbody>
</table>
Table 2. Frequency distribution of predorsal and lateral scale counts for the Pacific species of *Bollmannia*.

<table>
<thead>
<tr>
<th>Species</th>
<th>Predorsal (6-10)</th>
<th>Lateral Rows (24-29)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td><em>B. chlamydes</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>B. ocellata</em></td>
<td>2</td>
<td>60</td>
</tr>
<tr>
<td><em>B. macropoma</em></td>
<td>1</td>
<td>13</td>
</tr>
<tr>
<td><em>B. stigmatura</em></td>
<td>38</td>
<td>40</td>
</tr>
<tr>
<td><em>B. umbrosa</em></td>
<td>26</td>
<td>58</td>
</tr>
<tr>
<td><em>B. marginalis</em></td>
<td>1</td>
<td>13</td>
</tr>
<tr>
<td><em>B. elongata</em></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 3. Lengths of upper jaw and head of the Pacific species of *Bollmannia* (in percent standard length).

<table>
<thead>
<tr>
<th>Species</th>
<th>Upper Jaw Length</th>
<th>Head Length</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(n) Range ( \bar{X} )</td>
<td>(n) Range ( \bar{X} )</td>
</tr>
<tr>
<td><em>B. chlamydes</em></td>
<td>(100) 12.3-15.0 13.7</td>
<td>(89) 27.7-33.0 30.7</td>
</tr>
<tr>
<td><em>B. ocellata</em></td>
<td>(99) 10.5-15.0 13.2</td>
<td>(85) 25.4-31.9 29.1</td>
</tr>
<tr>
<td><em>B. macropoma</em></td>
<td>(17) 12.4-14.0 13.3</td>
<td>(17) 27.3-32.5 30.0</td>
</tr>
<tr>
<td><em>B. umbrosa</em></td>
<td>(43) 12.5-14.2 13.4</td>
<td>(43) 28.0-32.2 30.5</td>
</tr>
<tr>
<td><em>B. marginalis</em></td>
<td>(40) 10.7-13.7 11.9</td>
<td>(56) 25.3-33.1 28.7</td>
</tr>
<tr>
<td><em>B. elongata</em></td>
<td>(34) 10.8-12.8 11.6</td>
<td>(34) 24.8-31.0 27.3</td>
</tr>
</tbody>
</table>
Table 4. Eye diameter of the Pacific species of *Bollmannia* (in percent standard length).

<table>
<thead>
<tr>
<th>Species</th>
<th>(n)</th>
<th>Range</th>
<th>( \bar{X} )</th>
</tr>
</thead>
<tbody>
<tr>
<td>B. chlamydes</td>
<td>103</td>
<td>6.3-8.9</td>
<td>7.5</td>
</tr>
<tr>
<td>B. ocellata</td>
<td>121</td>
<td>6.9-9.9</td>
<td>8.1</td>
</tr>
<tr>
<td>B. macropoma</td>
<td>17</td>
<td>8.0-9.9</td>
<td>9.1</td>
</tr>
<tr>
<td>B. stigmatura</td>
<td>78</td>
<td>8.1-10.8</td>
<td>9.2</td>
</tr>
<tr>
<td>B. umbrosa</td>
<td>42</td>
<td>7.0-9.5</td>
<td>8.1</td>
</tr>
<tr>
<td>B. marginalis</td>
<td>40</td>
<td>7.0-8.9</td>
<td>7.7</td>
</tr>
<tr>
<td>B. elongata</td>
<td>34</td>
<td>6.7-9.2</td>
<td>7.8</td>
</tr>
</tbody>
</table>
Table 5. Greatest body depth and least caudal depth of the Pacific species of *Bollmannia* (in percent standard length).

<table>
<thead>
<tr>
<th>Species</th>
<th>Greatest Body Depth</th>
<th>Least Caudal Depth</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(n)</td>
<td>Range</td>
</tr>
<tr>
<td><em>B. chlamydes</em></td>
<td>103</td>
<td>20.0-26.7</td>
</tr>
<tr>
<td><em>B. ocellata</em></td>
<td>102</td>
<td>17.5-27.2</td>
</tr>
<tr>
<td><em>B. macropoma</em></td>
<td>17</td>
<td>18.2-21.9</td>
</tr>
<tr>
<td><em>B. stigmatura</em></td>
<td>147</td>
<td>17.5-24.0</td>
</tr>
<tr>
<td><em>B. umbrosa</em></td>
<td>43</td>
<td>17.2-24.5</td>
</tr>
<tr>
<td><em>B. marginalis</em></td>
<td>40</td>
<td>16.9-22.5</td>
</tr>
<tr>
<td><em>B. elongata</em></td>
<td>34</td>
<td>16.8-21.9</td>
</tr>
</tbody>
</table>
Figure 1. *Bollmannia* frenum showing frenal supports.
Figure 2. Dorsal and lateral views of B. ocellata head showing cephalic laterosensory pore system and sensory papillae system as illustrated for Ginsburg's unpublished MS (delineator unknown).
Figure 3. Lateral view of *B. stigmatura* head showing cephalic laterosensory pore system and sensory papillae system as illustrated for Ginsburg's unpublished MS (delineator unknown).
Figure 4. *Bollmannia chlamydes*, female, 73.1 mm SL.
Figure 5. *Bollmannia ocellata*, female, 83.3 mm SL.
Figure 6. *Bollmannia pawneea* (= *Bollmannia ocellata*) as illustrated by L. Cable for Ginsburg's unpublished MS.
Figure 7. *Bollmannia macropoma*, male, 74.1 mm SL.
Figure 8. *Bollmannia stigmatura*, male, 74.7 mm SL.
Figure 9. *Bollmannia umbrosa*, male, 69.3 mm SL.
Figure 10. *Bollmannia umbrosa* as illustrated by L. Cable for Ginsburg's unpublished MS (caudal and pectoral fins damaged).
Figure 11. *Bollmannia marginalis*, female, 40.0 mm SL.
Figure 12. *Bollmannia marginalis* as illustrated by L. Cable for Ginsburg's unpublished MS.
Figure 13. *Bollmannia elongata*, holotype, female, 66.5 mm SL.