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SCALES OF PANAMA FISHES.

BY T. D. A. COCKERELL.

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The year before last, when Dr. S. E. Meek was working at the U. S. National Museum on his collection of Panama fishes, he very kindly allowed me to take scales of a large number of species. The present report deals with this material, including also a few species collected by others in the Republic of Panama or the Canal Zone. Whenever the collector's name is not given, it is to be understood that the material was obtained by Messrs. Meek and Hildebrand.

The following key enumerates the species studied, and shows how they may be separated. With few exceptions, a single normal (not regenerated) scale from the middle of the side will serve to distinguish a species from all the others in the collection.

- Scales cycloid (obscurely ctenoid in *Gerres*) . . . . . 1.
- Scales ctenoid . . . . . 15.
- 1. Circuli and radii entirely transverse (*Clupeidæ*)
  - Opisthonema libertate* Günther. (Taboga I.)
  - Circuli transverse, basal only; no radii, but basal margin lobed, and radial folds faintly indicated (*Atherinidæ*)
    - Atherina aræa* Jordan & Gilbert. (Porto Bello.)
  - Circuli concentric; radii absent . . . . . 2.
  - Circuli concentric, or rarely (*Opisthopterus*) essentially transverse; radii present, not transverse, or (*Gastropolecus*) only partly so . 3.
- 2. Circuli complete; scales very minute (*Belonidæ*)
  - Tylosurus scapularis* Jordan & Gilbert. (Balboa.)
  - Circuli absent from apical part of scales (*Characidæ*)
    - Roeboides guatemalensis* Günther. (Gatun R.)
- 3. Scales elongate; with very numerous radii all around (*Rypticidæ*)
  - Rypticus nigripinnis* Gill. (Corazal.)
- Radii not all around . . . . . 4.

4. Scales very broad and short, with very few radii; circuli absent in apical field . . . . . 5.  
Scales longer than broad, or if broader than long, not excessively so . 6.
5. Circuli extremely dense, essentially transverse (Clupeidæ)  
*Opisthopterus dovii* Günther. (Panama market.)  
Circuli not dense, concentric (Hemiramphidæ)  
*Hyporhamphus unifasciatus* Ranzani. (Balboa.)
6. Small scales, with rounded laterobasal corners, and numerous radii . 7.  
Larger scales, with angular or subangular laterobasal corners, or if (*Gastropolecus*) sometimes rounded, then radii very few . . . 9.
7. Lateral and apical circuli crossed by fine radial lines of hyaline dots (Pleuronectidæ) . . *Citharichthys spilopterus* Günther.  
lower side (Toro Point.)  
No such lines of hyaline dots . . . . . 8.
8. Radii (all basal) less than ten (Pleuronectidæ)  
*Paralichthys woolmani* Jordan & Williams.  
upper and lower sides (Taboga I.)  
Radii extremely numerous; circuli in apical field broken up (Dactyloscopidæ) . . . . . *Dactylagnus mundus* Gill. (Taboga I.)
9. Radii few, mostly apical; or when many basal, central region of scales with coarse radial reticulation (Characidæ) . . . . . 10.  
Radii numerous, all apical; basal margin not lobed (Characidæ) . 11.  
Radii apical and basal; basal margin deeply lobed; center of scale not reticulated (Characidæ) . *Curimatus magdalenæ* Steindachner  
(Rio Abaco.)  
Radii basal . . . . . 12.
10. Circuli absent in apical field; centre of scale with a minute reticulation derived from the circuli  
*Gastropolecus maculatus* Steindachner. (Creek near Chorera.)  
Circuli broken up, but coarse and conspicuous, in apical field; some scales with a central reticulate pattern derived from the radii  
*Piabucina panamensis* Gill. (Rio Calobre.)
11. Circuli represented in apical field by a broken zigzag pattern  
*Astyanax fischeri* Steindachner. (Creek near Chorera.)  
Circuli not showing a zigzag pattern in apical field  
*Astyanax grandis* Meek & Hildebrand. (Rio Abaco.)
12. Scales longer than broad, with only three or four radii, in deep folds; basal margin lobed (Synodontidæ)  
*Synodus evermanni* Jordan & Bollman. (Taboga I.)  
Scales broader than long . . . . . 13.
13. Radii 6 to 8; basal margin strongly crenulate (Xystematidæ)  
*Gerres rhombeus* C. & V. (Mindi Cut.)  
Radii more than ten; basal margin without regular crenulations (Pœciliidæ) . . . . . 14.
14. Circuli obtusely angulate in median line above nucleus  
*Pœcilia sphenops* C. & V. (Corazal.)

[Circuli not angulate in median line above nucleus; scales larger.

*Xiphophorus helleri* Heckel. (Obispo, Mexico; S. E. Meek.)]

15. Apical margin with a single row of sharp teeth, and no ctenoid elements below them; nucleus just below apical margin . . . . . 16.  
 Apical field with one or more rows of ctenoid elements below the marginal teeth . . . . . 19.
16. Scales with rounded base (Pleuronectidæ)  
*Citharichthys spilopterus* Gthr., upper side.  
 Scales with truncate base, the laterobasal corners evident; apical margin usually like the transverse section of a roof of a house (Gobiidæ) . . . . . 17.
17. Basal radii about 7 to 9 . . . . . *Chonophorus nelsoni* Evermann  
 (Rio Culebra.)  
 Basal radii more numerous . . . . . 18.
18. Scales 2.5-3 mm. long . . . . . *Philypnus maculatus* (Chepo.)  
 Scales less than 2 mm. long . . . *Eleotris pisonis* Gmel. (Porto Bello.)  
*Gobius claytoni*. (Mindi.)  
*Gobius soporator* C. & V. (Fox Bay, Colon.)
19. Scales conspicuously longer than broad, parallel sided . . . . . 20.  
 Scales broader than long, or at most a little longer than broad . . 22.
20. Scales minute, much less than 2 mm. long; nucleus never elongate, always subapical (Soleidæ) . . . . . 21.  
 Scales larger, at least over 2 mm. long; nucleus often elongated, and then radii not reaching middle of scale; apical teeth often truncate (Serranidæ) . *Petrometopon panamensis* Steind. (Taboga I.)  
*Bodianus acanthistius* Gilbert. (Panama market.)  
*Mycteroperca xenarcha* Jordan. (Corazal.)  
*Paranthias fuscifer* C. & V. (Taboga I.)
21. Scales more or less narrowed apically; radii 3 to 5  
*Achirus fluviatilis*. both sides (Rio Chorera.)  
 Scales not narrowed apically; radii very many  
*Symphurus plagusia* B. & S. both sides (Fox Bay, Colon.)
22. Basal radii few (4 to 6), and widely spaced; subapical ctenoid elements brick-like (Mullidæ)  
*Upeneus maculatus* Bloch. (Fox Bay.)  
 Basal radii many, or at least closer together, usually arranged in fan-like manner; subapical ctenoid elements not brick-like . . 23.
23. Scales minute, 1.5 mm. or less long; only about three rows of distinct ctenoid elements below the marginal teeth (Scienidæ)  
*Menticirrhus martinicensis* C. & V. (Fox Bay.)  
 Scales larger . . . . . 24.
24. Elements of ctenoid patch triangular, feebly developed, with no sharp salient marginal teeth (Xystæmatidæ)  
*Eucinostomus californiensis* Gill. (Mindi Cut.)  
 Elements of ctenoid patch well developed; marginal teeth salient, narrow and sharp, or (*Stellifer* and *Orthopristsis*) often slightly bifid . . . . . 25.

25. Submarginal ctenoid elements like the marginal; ctenoid patch very large; basal margin very strongly crenate, the lobules free from circuli (Cichlidæ) . . . *Æquidens cæruleopunctatus* Kner & Steind.  
 (Rio Las Sabanas, A. H. Jennings.)  
*Satanoperca crassilabris* Steind. (Frijoles, Canal Zone.)  
 Submarginal ctenoid elements unlike the marginal . . . . . 26
26. Submarginal ctenoid elements long, strongly ridged; basal margin not crenulate (Sciænidæ) . . . *Paralonchurus dumerili* Bocourt.  
 (Panama, C. H. Gilbert.)  
 Submarginal ctenoid elements short . . . . . 27.
27. Basal margin not crenulate (Sciænidæ)  
*Odontoscion dentex* C. & V. (Toro Point.)  
*Stellifer colonensis* (Mindi Reef.)  
 Basal margin crenulate (Hæmulidæ)  
*Orthostæchus maculicauda* Gill. (Taboga I.)  
*Pomadasis bayanus* Jord. & Everm. (Corazal.)  
*Pomadasis macracanthus* Gthr. (Balboa.)  
*Orthopristis chalceus* Gthr. (Balboa.)

CHARACIDÆ.

An account of the scales of the neotropical Characidæ was published in *Annals Carnegie Museum*, ix, 1914. While recording the Panama species, I give some notes on others, supplementary to the paper mentioned.

BIVIBRANCHIINÆ. *Bivibranchia protractila* Eigenmann. Rockstone, British Guiana (Eigenmann). U. S. N. M. A remarkable fish, resembling *Albula vulpes*.

Scales about 2 mm. long and over 2.5 wide, broadly rounded apically, sides sloping, base very broadly truncate, laterobasal angles distinct, basal margin with a strong median lobe, nucleus central; circuli coarse, absent from apical field. No radii, but a radial fold on each side of basal lobe. The scale resembles that of the Curimatinae, but is peculiar for the single basal lobe, and the thin weak apical field, without radii or marginal teeth.

ANOSTOMATINÆ. *Schizodon fasciatus* Spix. Bolivia (Gibbon). U. S. N. M.

Large red scales, subquadrate, about 9.5 mm. long and broad, basal margin strongly bilobed, circuli very fine and dense, nucleus approximately central; apical radii few and weak, except one on each side, basal radii rudimentary; apical field coarsely pustular. The Anostomatine genera known to me are separable thus:

Scales with a strong radial line extending horizontally to each side, and two (rarely one) extending upward to apex, in lateral line scales sometimes two also to base . . . . . *Anostomus*.

Scales without such radial pattern; apical field with weak radii, usually rather numerous . . . . . 1.

1. Nucleus well below middle . . . . . *Leporinus*.

Nucleus about middle . . . . . *Schizodon*.

BRYCONINÆ. *Brycon dentex* Gthr. Nicaragua (L. F. H. Birt.). U. S. N. M. Scales about 11 mm. long and 13 broad. The three before me

are all latinucleate, but they agree with those of *B. falcatus* in all essential characters; the apical radii are many and parallel, and the apical margin is strongly crenulate or subdentate, though not ctenoid in any proper sense.

**TETRAGONOPTERINÆ.** Two species of *Astyanax* are given in the table above. *A. fischeri* is related in the characters shown by the scales to *A. bimaculatus*, though the scales are much smaller (5–5.5 mm. broad), the circuli are less dense, and the weak subparallel apical radii are very different. The relationship is perhaps actually closer with the still smaller scales of the *A. polylepis* group. *A. grandis* is very close to *fischeri*. Thus the two Panama species form a little group intermediate between the South American groups of *A. bimaculatus* (large scales with very coarse spreading apical radii) and of *A. polylepis*, *abramoides*, etc. (small scales with very weak apical radii). The *A. mucronatus* group (with V-like apical radial pattern) stands apart from all these; to it must be added *A. fasciatus* Cuvier, Rio Primero, Argentine (J. W. Titcomb). The *mucronatus-fasciatus* group is typical *Astyanax*. *Poecilurichthys*, which Eigenmann has recently treated as a distinct genus, is typified by *A. bimaculatus*; but according to scale characters we should be inclined to include in it some of the species which Eigenmann, in his catalogue, has left in typical *Astyanax*.

**GASTEROPELECINÆ.** *Gasteropelecus maculatus* has scales which do not differ in any tangible way from those of *G. sternicla* L.

**PIABUCINÆ.** *Piabucina panamensis* has scales of the same general type as those of *Chalceus macrolepidotus*, but much smaller (length 7, breadth 8 mm.). The intermediate, minor apical radii are not so evident in the *Piabucina* as in the *Chalceus*. In all respects the scales of *Piabucina* are essentially as in the African genus *Alestes*. Both show a radial polygonal pattern in the middle, at least in some of the scales. Are the Piabucinæ separable as a subfamily from the Alestinæ?

**HYDROCYNINÆ.** *Luciocharax insculptus* Steind., Rio Abaco, Panama (Meek & Hildebrand). Scales subquadrate, about 6 mm. long and broad; basal margin strongly undulate, or emarginate in middle; nucleus a little above the middle; circuli fine; a few basal, apical and lateral radii (1 or 2 apical, 1 to 3 basal, 1 to 5 lateral, but when more than one lateral, they are only partly developed), in Alestiform fashion; apical field without circuli, but thrown into strong parallel pleats or folds (not radii), which end as strong sharp teeth on the margin. The circuli are microscopically beaded. These are ctenoid scales, using that word in a purely descriptive sense. There is no resemblance to *Hydrocynus*, at least judging from the scales of the latter genus seen by me, which are, however, apparently quite immature. Eigenmann states that adult scales of *Hydrocynus* have denticulate apical margins. The scale of *Luciocharax* is singularly like that of *Phractolemus*.

**CHARACINÆ.** The genera of this subfamily now before me may be separated thus:

Apical field with numerous sharp isolated teeth in about four rows, one of which is marginal; base broadly rounded, with rather coarse circuli, and no radii; nucleus central. The arrangement of the teeth reminds one of the Macruridae.

*Cynopotamus argenteus* Val., Paraguay (Page); U. S. N. M.

No such teeth in apical field; scale cycloid . . . . . 1.

1. Apical field with many radii, between which the circuli are very coarse and widely spaced, in complete contrast with those of the base and sides of the scale; scale about 4.75 mm. long and 6 broad; laterobasal corners rounded; no basal radii. System of circuli like that of the African genus *Sarcodaces*

*Salminus maxillosus* C. & V. Paraguay (Page); U. S. N. M.

Apical field without radii or circuli . . . . . 2.

2. Circuli very dense, largely transverse, wavy, broken and branching; weakly developed and very variable undulating transverse radii; scales transversely oval or nearly circular. These look like clupeid scales . . . . . *Bramocharax bransfordii* Gill.

Nicaragua (Bransford); U. S. N. M.

Circuli not very dense; apical field with evident growth-lines; no trace of radii anywhere . . . . . 3.

3. Scales small, transversely short-oval . *Ræbooides guatemalensis* Gthr. Scales extremely broad, but of the same type

*Charax* and *Acanthocharax*.

There are clearly indicated several tribes; Characini (*Charax*, *Acanthocharax* and *Ræbooides*), Salminini (*Salminus*), and Cynopotamini (*Cynopotamus*). The *Bramocharax*, if correctly determined, represents another group.

CURIMATINÆ. *Curimatus magdalene* has scales like those of *C. spilurus* Gthr.

CLUPEIDÆ.

*Opisthonema libertate* scales (mine evidently immature) do not differ from those of *O. oglinum*, except in the absence of pitting. The first transverse radius is complete, the second always interrupted.

*Opisthopterus dovii* belongs to the Pristigasterinæ. The five transverse circuli and the hyaline apical field are as in the Clupeinæ, but the few radii in the basal field are directed obliquely basad, instead of being transverse. There are fine irregular apical radii, poorly developed. The apical margin is not dentate.

SYNODONTIDÆ.

*Synodus evermanni* scales are like those of *S. foetens*, but smaller, with the nucleus nearer the centre. Probably most of this difference is due to immaturity.

POECILIIDÆ.

*Poecilia sphenops* scales do not differ appreciably from those of *P. butleri*. *Xiphophorus helleri* scales resemble in structure those of *Pseudoxiphophorus*

*phorus bimaculatus* Heckel, from Quirigua, Guatemala (W. P. Cockerell), but differ in detail thus:

Scales subquadrate, about 5 mm. long and broad; apical circuli denser

*Xiphophorus.*

Scales broader than long, about 3.6 long and 4.5 broad; apical circuli not dense . . . . . *Pseudoxiphophorus.*

#### BELONIDÆ.

*Tylosurus scapularis* scales look like very young scales of *T. acus*. The structure is entirely the same. My material of *scapularis* is probably immature.

#### HEMIRHAMPHIDÆ.

*Hyporhamphus unifasciatus* from Balboa, Canal Zone, differs from the same species from Woods Hole, Mass., in the absence of the dense fine circuli in the apical field, but it is immature. At the sides of the apical field in the Balboa fish there are variable feebly developed circuli running upward instead of transversely, about two-thirds as far apart as the uppermost ones of the basal field, which they almost meet. In the narrow zone between these two sets of circuli are rudiments of the fine transverse circuli which are so conspicuous in the Woods Hole fish. The Balboa fish is presumably true *H. unifasciatus*; that from Woods Hole should perhaps be referred to *H. roberti*. It remains to be seen whether fully mature scales from the Panama region will be readily distinguishable from those of the northern fish.

#### ATHERINIDÆ.

*Atherina araea* scales agree entirely in type with those of *A. pinguis* from Australia, even to the frequent presence of a curious nuclear pit. *A. araea* scales are however much smaller, about 1.5 mm. long and 3.5 broad. In Mem. Queenst. Mus., Dec., 1913, I have discussed the scales of *Atherina*, and given an account of another Panama species, *A. stipes*. The lobules in the middle of the basal margin of *A. araea* are usually two, but sometimes three.

#### MULLIDÆ.

*Upeneus maculatus* scales do not differ appreciably from those of *U. dentatus*.

#### RYPTICIDÆ.

The scales of *Rypticus* are so entirely different from those of the Serranidæ that a distinct family appears to be indicated. The absence of the anal spines, and other characters, further distinguish the group. The group is called Grammistinæ by Boulenger, and appears to include three genera. Jordan and Evermann recognize two subfamilies, Grammistinæ and Rypticinæ.

Scales of *Rypticus nigripinnis* are minute, about 1.3 mm. long and .4 broad; greatly elongated, with rounded ends; nucleus central, elongated; radii numerous, all around; circuli coarse; margin of course wholly cycloid. Only a very small area is covered by skin. The apical

end is distinctly larger than the basal, and the apicolateral radii are curved, with the convexity upward. These scales are extraordinarily similar in general type to those of some Ophidiidæ, as *Lepophidium microlepis*.

## SERRANIDÆ.

*Petrometopon*, *Bodianus* and *Mycteroperca* are Epinephelinæ, and have the characteristic elongated, parallel-sided scales of that subfamily. Scales of *P. panamensis* are broader than those of the Australian *Epinephelus megachir*, but otherwise little different. *Paranthias furcifer* (subf. Anthiinæ) has scales about 5 mm. long and 3.5 broad, entirely of the *Petrometopon* type. Thus it appears that the Anthiinæ can not be separated from the Epinephelinæ on the scales. *Bodianus acanthistius* scales, only about 2.5 mm. long, are structurally like the others, but with rather conspicuously bulging or convex sides. *Mycteroperca* is like *Bodianus*, but the scales are larger and the sides straighter.

## HÆMULIDÆ.

The scales in this family, so far as seen, are very uniform, subquadrate, usually broader than long, always with the lower margin crenate or scalloped, a character which distinguishes them from the Sciaenidæ. In *Pomadasis* the scales are about as long as broad, and the marginal teeth are pointed. In *Orthostoechus* the scales are broader than long, length about 3, breadth 3.75 mm.; the marginal teeth are pointed. In *Orthopristis* the marginal teeth are subtruncate or obscurely bifid, and the scale is very little broader than long.

## XYSTAEMATIDÆ.

The scale of *Gerres rhombeus* appears cycloid, but under the compound microscope the ctenoid patch, of weak transversely diamond shaped dentiform structures, can be seen. These are even crossed by broken and rudimentary transverse circuli. In the *Eucinostomus* these ctenoid elements are narrower and rather more distinctly dentiform, without rudiments of circuli; but the general type of structure is the same. The Australian *Xystaema darnleyensis* has lost the ctenoid patch altogether. Both the Panama species have transverse circuli reaching the middle of the lateral margin at right angles with it.

## SCIAENIDÆ.

The lateral circuli are directed vertically, instead of transversely as in the last family. The scales are broader than long, and the lower margin is without distinct crenulations. Leaving out *Cynoscion*, the scales are of a very uniform type, but *Paralonchurus dumerili* is readily separated from the others by the comparatively long and narrow elements of the ctenoid patch. It has the marginal spines stout, obtusely pointed.

## CICHLIDÆ.

Cichlid scales are broader than long (sometimes not greatly so), with the lateral circuli vertical, and the basal margin strongly crenate. In my



table in Bull. Bureau Fisheries, XXXII, p. 166, both the Panama species run to *Geophagus brasiliensis*, though the *Satanoperca* scale is not quite so broad as the others. The Brazilian *Chaetobranchopsis ocellaris* does not have basal lobules free from circuli; but such lobules are well developed in *Chaetobranchus flavescens*, as in the Panama species. *Tilapia nilotica* has short broad lobules free from circuli.

## GOBIIDÆ.

The Panama scales confirm the very distinct and nearly uniform Gobiid type, already discussed elsewhere.

## DACTYLOSCOPIDÆ.

*Dactylagnus mundus* has already been discussed in Proc. Biol. Soc. Wash., XXVI, p. 91.

## PLEURONECTIDÆ.

*Paralichthys woolmani* scales, as represented by my material, are much smaller than those of *P. oblongus*, but the structure is the same.

*Citharichthys spilopterus* are also small, but structurally closely resemble *Syacium papillosum*, the lateral field being essentially after the manner of this species, not as in *Citharichthys arctifrons*.

## SOLEIDÆ.

*Achirus fluviatilis* scales agree structurally with *A. lineatus*. *Symphurus plagusia* scales essentially agree with those of *S. piger*.

NOTE.—In Proc. Biol. Soc. Wash., XXVI, p. 77, the scale of *Bregmaceros* is discussed, and said to apparently lend some support to the Tims theory of the origin of teleostean scales. Further investigation shows that this idea was based on an error of interpretation, and other studies appear to show conclusively that the Tims theory is incorrect.