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THE SCALES OF SOME AMERICAN CYPRINIDÆ.

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The sculpture of a Cyprinid scale consists of radiating and concentric lines, which we term *radii* and *circuli*. In *Salmo* only the circuli are found, but in no Cyprinid have we found the radii wholly absent. In the Catostomidæ the radii are both basal and apical, but in the American Cyprinidæ the basal radii are usually absent, while the apical ones are often greatly reduced in number. The circuli are always present, both apical and basal, in these fishes; but in the Characinid *Cheirodon insignis*, from Panama, they are confined to the basal half of the scale.*

The herbivorous genus *Chrosomus* has the radii extending all around the scale, as in *Catostomus*. Among the genera usually referred to Leuciscinæ basal radii occur in *Rhinichthys* and *Agosia*, closely related genera which form a distinct tribe or subfamily. They are also well developed in some, but not all, of the scales of *Leuciscus orcutti*, which thereby stands apart from the other American species ascribed to *Leuciscus*, and nearer to the palæarctic species. The European Miocene *Leuciscus æningensis* (Agassiz) from Æningen, has radii strongly developed all around, a scale very much more like that of *Chrosomus* than those of the ordinary American so-called Leucisci. In the Japanese *Paracheilognathus rhombeus* (Schleg.) there are no basal radii, but the apical radii are strongly zigzag, an extreme exaggeration of a character never more than slightly indicated in the American Cyprinids. Species of *Labeo*, *Chelæthiops*, *Barilius* and *Barbus*, from the River Nile, all have basal as well as apical radii. In *Barbus perince* Rüpp. the scale is

* In *Fundulus*, *Apomotis*, etc., the radii are all basal.

large, with few radii, and the basal margin is strongly undulated; a scale extraordinarily like that of the American Catostomid *Carpioides velifer*. *Barbus bynni* Forsk. has a very different

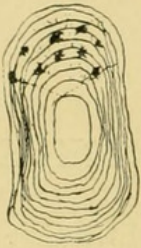


Fig. 1. *Salmo stomias*.
Showing absence of radii.

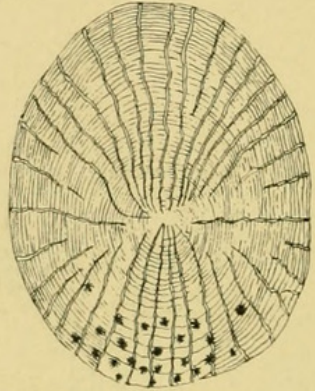


Fig. 2. *Catostomus griseus*.
Showing basal and apical radii.

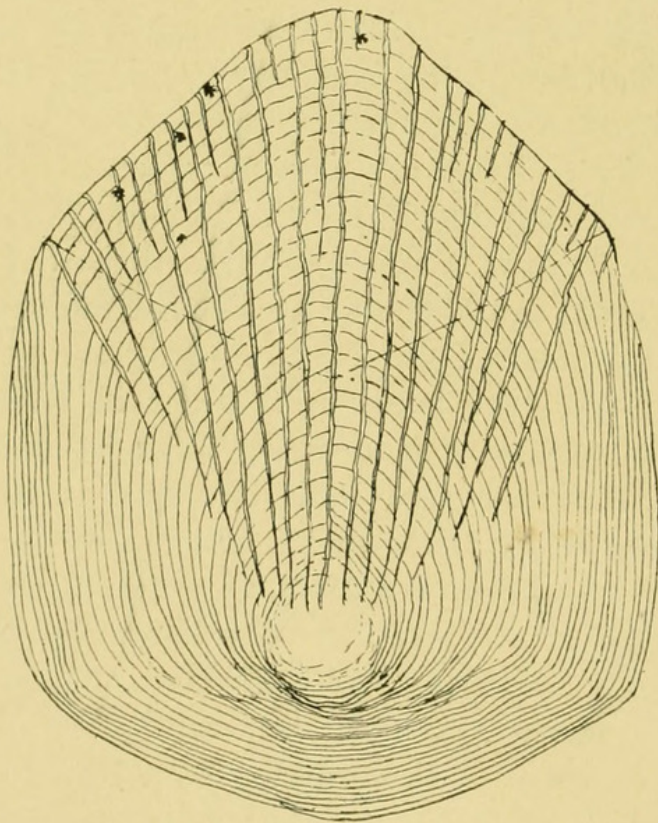
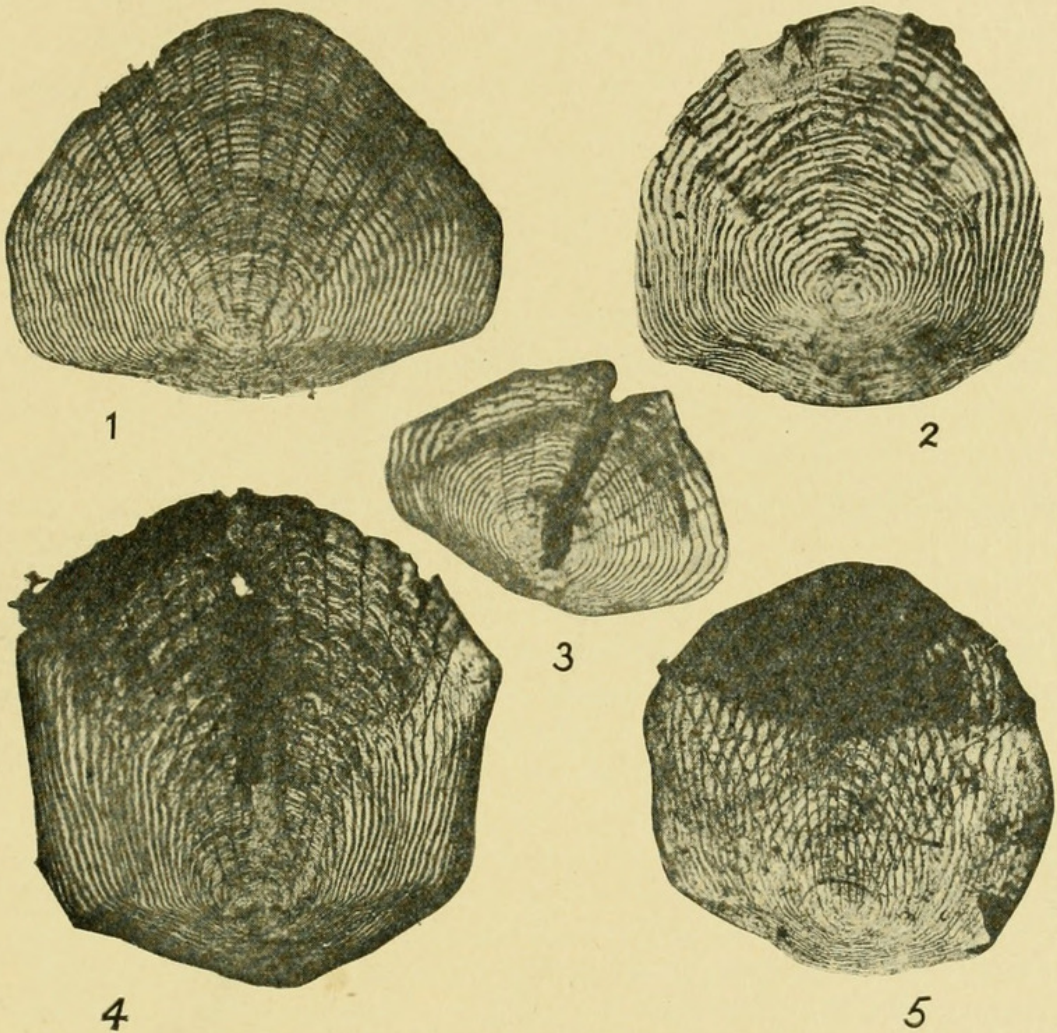


Fig. 3. *Notropis cornutus*.
Showing radii in apical field only.

scale, with numerous apical radii. In these Old World fishes the circuli are very numerous and regular, whereas in many American forms they become fewer and variously modified. In *Leuciscus* the apical circuli (*i. e.* all apical of the nuclear area)



SCALES OF AMERICAN CYPRINIDÆ.

1. *Ericymba buccata*.—Wild Cat Creek, Ind. Apical circuli flattened.
2. *Ptychocheilus grandis*.—Cache Cr., Calif. Apical circuli flattened, radii few.
3. *Opsopoeodus Osculus*.—Houston, Texas. Apical circuli flattened, radii few.
4. *Semotilus corporalis*.—Norfolk, N. Y. Apical circuli angulate.
5. *Semotilus atromaculatus*.—Cross Lake, Thoroughfare, Maine. Apical circuli angulate, radii many.

are frequently irregular and broken; in *Semotilus* they are further modified, being very distinctly angled in the median line, or inversely V-shaped. *Couesius*, which is almost the same as *Semotilus*, and should stand next to it in the system, has just the same characteristic angled circuli. On the other hand, *Ptychocheilus grandis* is entirely different, with the apical circuli flattened rather than angled medially. *Phenacobius mirabilis* has strongly angled apical circuli as in *Semotilus*, the scales closely resembling those of *Semotilus corporalis*. *Hybopsis gelida* has the circuli as in *Ptychocheilus*, and is not related to *Phenacobius*. *Nocomis kentuckiensis*, usually referred to *Hybopsis*, but certainly not congeneric with it, has angulate apical circuli, as in *Semotilus* and *Couesius*.

In the account of the scales of different genera which follows, it is to be understood that unless the contrary is specified, they have been taken from near the lateral line, at the level of the beginning of the dorsal fin. Scales from other parts of the body will show modifications; thus those on the caudal peduncle are often long and narrow.

Leuciscus Auctt. Amer.

These fishes are probably not congeneric with the European *Leuciscus leuciscus*, but as we do not at present possess any of the Old World species of the genus, we are not in a position to revise the nomenclature. The following key separates the species examined by us:

- Basal radii present, though not on all of the scales; basal circuli very much closer and more numerous than in *margarita* (which, though placed by Jordan and Evermann in the same immediate group, is not at all related); apical radii numerous (15 to 29, counting the partly developed ones); *peritoneum* reddish-black, with dots very thickly strewn on a silver ground . . . *L. orcutti* (Eigenmann & Eigenmann).
Santa Ana R., Calif.
- Basal radii absent on all the scales 1.
1. Scale much longer than broad 2.
Scale subcircular, or broader than long 3.
2. Scale large; radii numerous (12 to 14); subcentral apical circuli extremely irregular, but not angled; *peritoneum* silvery, with a profusion of small spots, most of them brown, some black
L. nigrescens (Girard).
Alamosa, Colo.
- Scale very small; radii less numerous (7 to 9); *peritoneum* brown on a silvery substratum, as in *Orthodon*, and *Acrocheilus*
L. intermedius (Girard).
Tempe, Arizona.

3. Scale very small, with a diameter of about 1 mm. or less . . . 4.
 Scale larger 5.
4. Scale subcircular; radii about 11; *peritoneum* silvery, with scattered pale brown spots and some black dots . . . *L. alicia* (Jouy).
 Provo R., Provo, Utah.
 Scale broad; radii fewer (9 or 10), without the outer diverging ones seen in *alicia*; *peritoneum* silver, with few diffuse large spots and a few black dots *L. elongatus* (Kirtland).
 Cold Run, Columbiana Co., Ohio.
5. Scale large and thin, with weak sculpture; radii 9 to 12; lateral circuli about 32 on each side in a lateral line scale; *peritoneum* silvery with many dark spots, the small ones black, the larger brown
L. hydrophlox (Cope).
 Ross Fork, Pocatello, Idaho.
 Scale broad; radii 12 to 14; *peritoneum* silvery, with few scattered spots
L. balteatus (Richardson).
 Green Lake, Seattle, Wash.; Elk Creek, Oregon.
 Scale circular, or approximately so, sculpture distinct 6.
6. Scale rather large; circuli more numerous than in *balteatus*; the more central apical circuli distinctly angled, approaching the condition of *Semotilus*; radii numerous (13 to 15); *peritoneum* not or hardly silvery, with rather few irregularly placed spots, some quite large, but not dark *L. carletoni* Kendall.
 Cross Lake, Thoroughfare, Maine.
 Scale rather small; *peritoneum* silvery 7.
7. Radii few (8 to 10); lateral circuli about 30 on each side; *peritoneum* silvery, nearly as in *neogæus*, but with more diffuse large brownish spots *L. egregius* (Girard).
 Willow Creek, Honey Lake Basin, Calif.
 Radii more numerous (10 to 13); *peritoneum* silver, with black spots on upper part *L. neogæus* (Cope).
 Eagle Lakes, Maine.
 Radii most numerous (15 to 20), but only about 10 complete; circuli about 20 on each side; *peritoneum* silver, with many spots, mostly reddish-brown, some black, none large, the general effect not dark, though the spots are numerous *L. margarita* (Cope).
 Cemetery Creek, Watertown, N. Y.

In a general way, the above arrangement is supposed to correspond more or less with the lines of evolution of the species, the more primitive ones coming first. On the whole the subgenera recognized by Jordan and Evermann are supported by the scale characters, with the exception of *L. orcutti*, which is out of place in *Phoxinus*, or at any rate is quite unrelated to *margarita* and *neogæus*. (The latter is supposed to be genuine *Phoxinus*.)

Lavinia Girard.

This genus does not belong to the Chondrostominae, but is closely related to the American species of *Leuciscus*. The teeth are only in one row, but they are distinctly hooked. It seems probable that the genus is derived from the American *Leuciscus*, rather than the reverse.

The scales of *Lavinia exilicauda* Baird & Girard (Coyote Creek, Calif.), are so like those of *Leuciscus hydrophlox* from Idaho that we can not find any satisfactory difference. The basal circuli are more indistinct and confused in *Leuciscus hydrophlox*, more distinct and separate in *Lavinia exilicauda*, but this is perhaps not constant. The scales of the *Leuciscus* seem on the whole to be broader. The anal fin of the *Lavinia* seems distinctly longer, but this is not constant. The peritoneum of the *Lavinia* is similar to that of *Leuciscus hydrophlox*, but the spots are much more crowded, giving a beautifully marbled effect, with large brown stellate spots and black dots. (This is wholly different from the peritoneum of *Orthodon*, etc.)

The long intestinal canal of the *Lavinia* is a good generic character, but it has probably been acquired independently of the other herbivorous groups.

Rutilus Rafinesque.

R. olivaceus (Cope) stands entirely apart, by its very small scales, with the radii few (7 to 10). *R. thalassinus* (Cope), according to our material from Pit River, Canby, Calif. (Stanford Univ. Coll.), is distinct by the large broad scale, with the rather numerous (11 to 15) apical radii very parallel. The others have the scale large and broad, and are more alike in the form of the radii, which are more convergent, going to a smaller nuclear area than in *thalassinus*. *R. bicolor* (Girard) has the least number of radii (5 to 8), and compared with *R. oregonensis* Snyder has the scale smaller, with the apical radii less spreading. *R. symmetricus* (Baird and Girard) has the basal area smaller than in *R. columbianus* Snyder; the basal area of *columbianus* is much larger than that of *bicolor*. The radii are about 9 to 13 in *columbianus*, and 7 to 11 in *oregonensis*. In *R. symmetricus* we found the radii very variable, 11 to 20, but this includes several different fishes from various parts of California and Oregon, which are at least subspecifically separable into four groups. (These segregates from *R. symmetricus* have been defined and discussed by the senior author, as far as the material permits, but more information is needed before publication. It will especially be necessary to determine the characters of the fishes now regarded as synonymous with *symmetricus*.)

Hybopsis Agassiz and **Nocomis** Gerard.

Nocomis Girard is a distinct genus. The following table separates the species of *Hybopsis* and *Nocomis* seen by us:



Cockerell, Theodore D. A. and Allison, Edith M. 1909. "The scales of some American Cyprinidae." *Proceedings of the Biological Society of Washington* 22, 157–163.

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