

Comparative Studies of the Scales in Japanese Freshwater Fishes, with Special Reference to Phylogeny and Evolution

(continued from vol. ii, p. 260)

HISAO KOBAYASI

(Dept. of Biol., Aiti Gakugei Univ.)

[IV] Particular Lepidology of Freshwater Fishes

I Suborder Isospondyli

Japanese Isospondyli has 20 families, 5 of which are related with freshwater. They are (1) Engraulidae, (2) Salmonidae, (3) Plecoglossidae and (4) Osmeridae, and besides these (5) Drosomateidae which sometimes comes into freshwater, and also the exotic families related to them, Coregonidae and Thymallidae, were used as materials for comparative study. Consequently as to 7 families in all, the phylogenetic relation as well as the difference of scale character were considered. All the other families being true marine fishes, relation between both will be studied in future.

[1] Engraulidae

Fishes belonging to this family are originally marine, but among them, some members of the genus *Coilia* often goes up a river and is admitted as a member of freshwater fishes. The fishes belonging to this family are all possessors of cycloid scales. Besides Japanese *Coilia mystus* and Korean *C. ectenes*, *Engraulis japonica*, a typical fish of this family; *Clupea*, *Sardinia* and *Harengula* in Clupeidae; and *Clupanodon punctatus* in Dorosomateidae were observed at the same time as comparative materials.

The scale character of the two species belonging to Genus *Coilia* is much the same and so similar as to be hardly distinguishable. In both, apical grooves form network, apical area having no ridges. Ridges, which are in basal and lateral areas, are very delicate, suddenly disappearing near boundary of apical area. A few basal grooves, starting from basal margin, run longitudinally — not being radial — and go backward, nothing that may be called true lateral grooves being observable. They are apical grooves extended forward or basal grooves extended backward, all of which are connected with network of apical grooves, except a few which disappear halfway.

As to ridges, right and left ones break once on longitudinal line, or both are connected making an obtuse angle, or sometimes one groove lies where this longitudinal line runs, dividing ridges into right and left ones. In short, ridges are not regularly circular, which fact is an important characteristic of scales of Engrauridae.

In the apical area, growth lines can be seen, and in basal area, annual zones or what may be called spawning marks.

Scales of *Coilia* are completely different from those of other Japanese freshwater fishes, and there is nothing else to be compared with them.

Discussion

The peculiar arrangement of basal ridges is also seen in *Clupea pallasii* of Clupeidae, telling the close affinity between *Coilia* and *Clupea*. When seen only from this character, *Clupea* resembles *Coilia* more than *Sardinia* and *Harengula* in Clupeidae.

Engraulis japonicus has two kinds of ridges, each of which is different in structure, having the same basal ridges as those of *Sardinia*, and apical ridges in ordinary scales consist of many ridges running almost transverse and not connected; these apical ridges, however, occasionally coil into many finger-pattern-like ridges groups (Fig. 12). Such a structure is seldom seen in fishes of any other family, but also seen in *Coilia nasus*, though not so finger-pattern-like, and they sometimes run irregularly, showing a tendency to resemble those of *Engraulis*. This proves the close affinity between *Engraulis* and *Coilia*.

Harengula zunasi in Clupeidae has two kinds of grooves, of which apical grooves are radial and indistinct, while basal grooves, the principal characteristic of this species, are not circular at all. This is exactly what the author (1950) pointed out showing the terms, radii and circuli to be inappropriate. Yet also in *Coilia*, ridges show a tendency to run more or less transverse. They differ from those of Salmonidae and Cyprinidae in being spread out to right and left as they run; and in this point it closely resembles *Sardinia* in Clupeidae. Grooves are not radial either, especially basal grooves running longitudinally. That grooves form an anastomosing network is more or less observable like dawn both in *Engraulis japonicus* of this family and in *Sardinia melanosticta* in Clupeidae, though not so distinctly as in *Coilia*.

After all, having the scale character proper to Engraulidae and the most peculiar structure in this family, *Coilia* is considered to be an isolated genus in Engraulidae. The character of ridges resembles that of *Clupea* in Clupeidae, and is also close to that of *Sardinia*; and it resembles *Engraulis* in that it makes irregular ridges, and when seen from the condition of grooves, is supposed to be related to *Sardinia* and *Engraulis*, and to be very distant in affinity from *Harengula* in Clupeidae. Again, scales of *Coilia* are so easy to peel off, that they are lost in many specimens; it is similar in this point to *Engraulis* and *Clupea*, but differs much from *Harengula* and *Clupanodon*.

Genus *Coilia*

The two species belonging to *Coilia* are admitted to be almost systematically perfect independent species, which is understood also in scale character. In the scale character of both, however, exists no fundamental difference, and there is no ground to make them different genera. It is recognized in scale character that these two species are closer in affinity to each other than to any other species. Scales on the right middle line of the belly make 'scutes'. According to JORDAN & HUBBS (1925), and IKEDA (1937), the Continental *Coilia* and that of the River Tikugo are of the same species, being regarded as *Coilia ectenes*, but the author supports YOSIDA's view

(1935) which regards them as independent species.

(1) *Coilia mystus* (Linnaeus) (Fig. 13)

Scales of c. b. s. and s. c. p. were torn off leaving nothing and could not be had by any means. Those collected from the part right above posterior 1/3 of the anal fin were observed.

Outline of scales are subsphaerical; middle part of basal margin is roundly swelled out; apical tip is somewhat sharply pointed; hardly any angle is observable; focus is situated in center of scales.

Apical area is filled all over with anastomosing network grooves, whose meshes are larger in center, becoming smaller before and behind it, and smaller still near apical margin. They are various in form and size, quadrangular to hexagonal shaped, with no angles near margin, ending freely and disappearing before they reach margin. Near boundary of lateral area, network is densely broken, some of which stretches forward into lateral area and then disappear, and the rest stretches still more forward into basal area, until it reach basal margin. Some of basal and lateral grooves are often branched. These lateral grooves, having no relation with lateral margin, cannot be called true lateral grooves, but they are only extension of apical and basal grooves, or what are extended forward from focal area. These basal and lateral grooves are hardly radial, several of which stretch forward from focus and tend to run longitudinally coming together on way into a single line.

In the fish from the river Tikugo, 28 cm, number of grooves reaching basal margin was 1 (sometimes 0) in c. b. s. scales, 10 (5-14) in scales in the part right above anal fin.

Scales have basal and lateral ridges, with no apical ridges at all. Ridges are all very delicate and dense, not regularly circular, but somewhat spreading out to right and left, and suddenly disappearing where it enters apical area. As to basal ridges, some are cut in middle, some connected, and some connected here making obtuse angles. Ridge space is almost same everywhere, winter zone being unseen.

No growth lines were seen.

The phylogenetical description having been written in detail in the passage of the family already, it will not be repeated here.

(2) *Coilia ectenes* TEMMINCK et SCHLEGEL (Fig. 14)

Specimen from Seoul, Korea, body length 24.5 cm.

Scales closely resemble those of *Mystus* (Generic name is omitted, and so is it in the following), being hardly distinguishable, but meshes of apical grooves are rather irregular in form and size, large and small, and various ones mixing together, and those elongated before and behind being observed in plenty; and sometimes network intrudes into lateral area, or it is not formed in a part of apical area.

Number of basal grooves is very small; extended apical grooves and those starting from focus, are connected on the way into a single line reaching basal margin, or disappear halfway before reaching it; those grooves which start from apical network grooves and extend to lateral area ending there freely, are hardly to

be seen.

In apical area, growth lines are seen, and in basal area, such a structure as winter zones or spawning marks; i. e., in this zone, ridges disappear making annual rings like those seen in *Pagrosomus*, but on entering lateral area, they suddenly become indistinct disappearing at last. It is observed in scales of this species that those ridges in front of focus run irregularly and tend to make a finger-pattern-like structure seen in *Engraulis*, which is a peculiar characteristic of Genus *Coilia*.

References

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(to be concluded)