

SYSTEMATIC POSITION, GEOGRAPHICAL DISTRIBUTION AND EVOLUTION OF THE CYPRINOID GENERA WITH A PROCUMBENT PREDORSAL SPINE.

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The *Mystacoleucus*-group of Cyprinoid genera, comprising *Mystacoleucus* Günther¹, *Matsya* Day,² *Spinibarbus* Oshima³ and *Spinibarbichthys* Oshima,⁴ is characterised by the presence of a forwardly directed spine in front of the dorsal fin. *Mystacoleucus* is distinguished from the other three genera by its relatively long anal fin, containing 8-10 branched rays as against the usual number 5. *Matsya* (= *Acanthonotus* Day⁵) and *Spinibarbichthys* possess a serrated dorsal spine, whereas in *Spinibarbus* the dorsal spine is smooth. In elucidating the systematic position of these genera most of the workers do not appear to have paid attention to the generic characters of Day's *Matsya*. Smith,⁶ who regarded it as congeneric with *Mystacoleucus*, gave no morphological details for his views. Unfortunately no specimen⁷ of *Matsya argentea* Day is available for study either in the Indian Museum or in the Bureau of Fisheries Bangkok. Three specimens of *Mystacoleucus marginatus* (Cuv. & Val.) were sent to me in 1932 by Dr. H. M. Smith with the remark: "Are these *Matsya argentea* Day?" This observation indicates that Smith had confused either a colour variety of the common species *M. marginatus* with Day's form or he may have obtained specimens of the species—*M. chilopterus* recently described from Siam by Fowler⁸. It may further be noted that Suvatti in his "Index to Fishes of Siam" lists only one species of *Mystacoleucus*, *M. marginatus* (C. V.), which is recorded from Northern, Central and Peninsular Siam. Day's diagnosis of *Matsya* is, however, fairly complete and it leaves no doubt that *Spinibarbichthys* should be regarded as a synonym of *Matsya*. In most of the Cyprinoid genera the nature of the dorsal spine, whether serrated or entire, strong and bony or feeble and articulated, is not considered of sufficient importance for separating genera. I am, therefore, in agreement with Nichols and Pope,⁹ Nichols¹⁰, Myers,¹¹ Mukerji,¹²

¹ Günther, *Cat. Fish. Brit. Mus.*, VII, p. 206 (1868).

² Day, *Faun. Brit. India*, Fish, I, p. 292 (1889).

³ Oshima, *Ann. Carnegie Mus.*, XII, p. 217 (1919).

⁴ Oshima, *Annot Zool. Japan*, XI, p. 10 (1926).

⁵ Day, *Fish. India*, (Suppl.), p. 807 (1888).

⁶ Smith, *Journ. Siam. Soc., Nat. Hist. Suppl.*, VIII, p. 185 (1931); *ibid.*, IX, p. 79 (1933).

⁷ Day's description of *Matsya argentea* was based on Tickell's manuscript description and figure of the species. Presumably Day did not examine any specimen of *M. argentea*.

⁸ Fowler, *Proc. Acad. Nat. Sci. Philadelphia*, LXXXVII, p. 112 (1935).

⁹ Nichols and Pope, *Bull. Amer. Mus. Nat. Hist.*, LIV, pp. 343, 344 (1927).

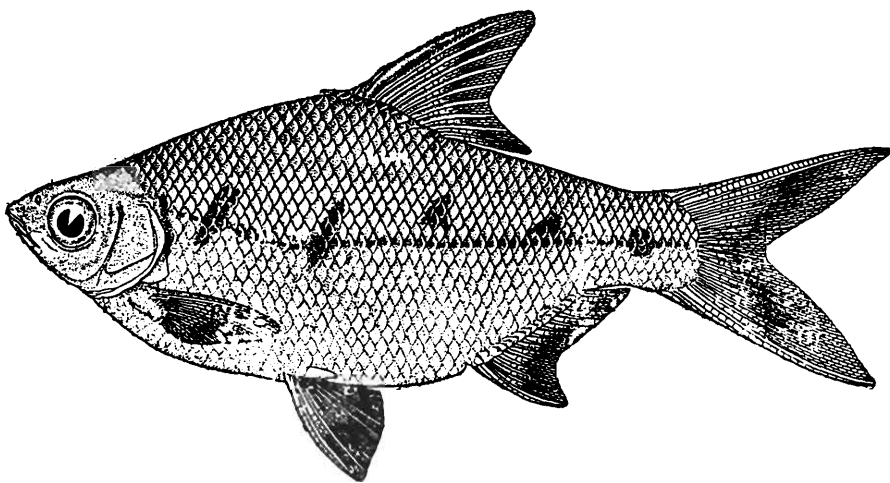
¹⁰ Nichols, *Bull. Amer. Mus. Nat. Hist.*, LVIII, pp. 11, 12 (1928).

¹¹ Myers, *Lingnan Sci. Journ.*, X, pp. 258, 259 (1931).

¹² Mukerji, *Rec. Ind. Mus.*, XXXIV, p. 284-286 (1932).

Mori¹ and Tchang² that *Spinibarbus* and *Spinibarbichthys* should be regarded as congeneric. Both these genera should, therefore, be assigned to the synonymy of *Matsya*. For the sake of convenience and on geographical grounds, it may, however, be desirable to treat *Spinibarbus* as a subgenus of *Matsya*.

In the four species of *Mystacoleucus*³ known so far, *M. marginatus*, *M. padangensis*, *M. chilopteris* and *M. atridorsalis* Fowler,⁴ the number of branched rays in the anal fin varies from 8 to 10 and I agree with Mukerji (*op. cit.*) that on this character alone they should be recognised as belonging to a distinct genus. It may here be noted that in a great majority of Cyprinoid genera there are only 5 branched rays in the anal fin. Any variation from this standard is, therefore, of special significance.



TEXT-FIG. 1.—Lateral view of *Mystacoleucus ogilbii* (Sykes). $\times \frac{3}{4}$.

Recently I collected two specimens of *Rohtee ogilbii* Sykes⁵ (text-fig. 1) at Kurnool which possess a well-marked procumbent, predorsal spine. Other specimens of the same species in the collection of the Indian Museum were examined and a predorsal spine, sometimes hidden below the scales (text-fig. 2 a) was found in all of them. In this species the number of branched anal rays varies from 13 to 14, and the number of scales in the lateral line is about 55. Its pharyngeal bones and teeth are similar to those of *Mystacoleucus* (text-figs. 2 b & d), and its scales also show a close resemblance to those of *M. marginatus* (text-figs. 2 c & e). It seems reasonable, therefore, to include *Rohtee ogilbii* in the genus *Mystacoleucus*, the definition of which should be emended to comprise forms having 8-14 branched rays in the anal fin. In none of the other species of *Rohtee*, such as *R. bakeri* Day, *R. cotio* (Ham.), *R. duvaucelli* (Cuv. & Val.), *R. vigorsii* Sykes, *R. belangeri* (Cuv. & Val.) and *R. feae* (Vinciguerra), I was able to detect any predorsal spine.

¹ Mori, *Studies on the Geographical Distribution of Freshwater Fishes in Eastern Asia* (Chosen: 1936). In the various lists of Chinese fishes *Spinibarbus* is recognised as a valid genus, while *Spinibarbichthys* is considered a synonym of *Spinibarbus*.

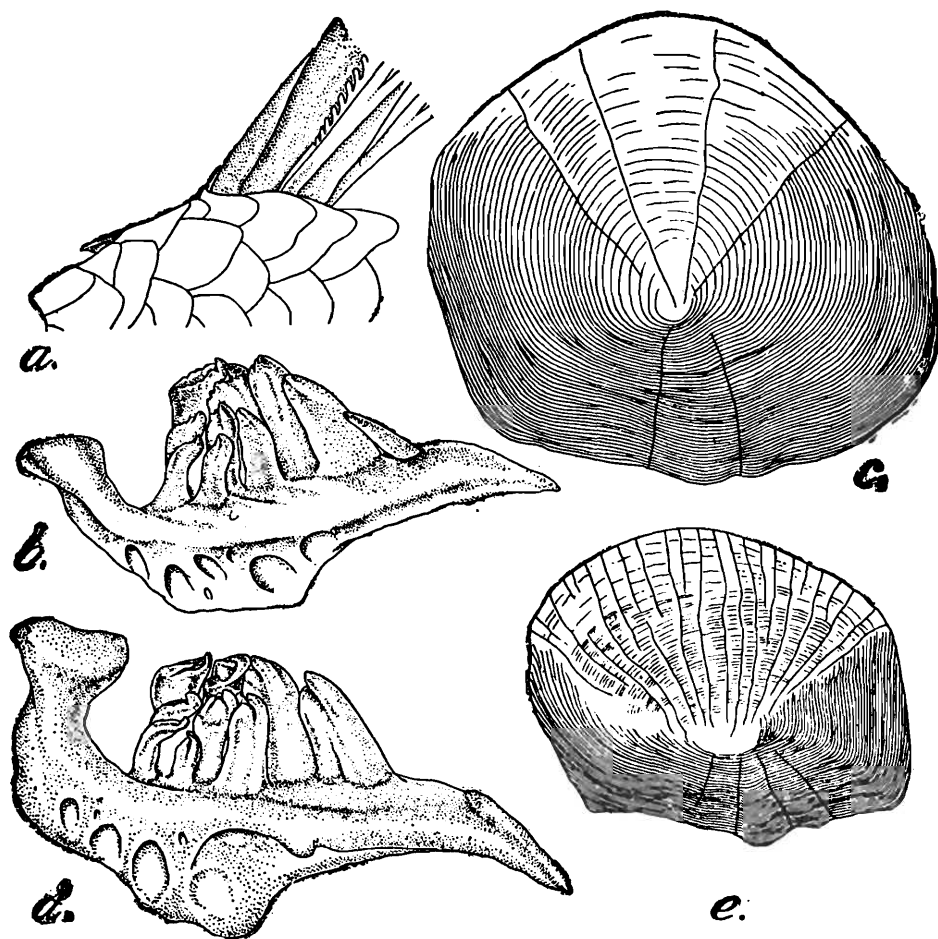
² Tchang, *Zoologia Sinica*, II, p. 43 (1936).

³ For up-to-date descriptions of *Mystacoleucus marginatus* (Cuv. & Val.) and *M. padangensis* (Blkr.) see Weber and de Beaufort, *Fish. Indo-Austral. Archipel.*, III, pp. 108-110 (1916).

⁴ Fowler, *Proc. Acad. Nat. Sci. Philadelphia*, LXXXIX, p. 196 (1937).

⁵ Sykes, *Trans. Zool. Soc. London*, p. 36 (1841).

The relationship of these species of *Rohtee* with Sykes' *R. ogilbii* is discussed later (*vide infra* p. 314).



TEXT-FIG. 2.—*Mystacoleucus ogilbii* (Sykes) and *M. marginatus* (Cuv. & Val.).

a. Anterior portion of base of dorsal fin of *M. ogilbii*, showing the position of the procumbent, predorsal spine $\times 2\frac{1}{2}$; b. Pharyngeal bone and teeth of *M. ogilbii*. $\times 7$; c. Scale from below base of dorsal fin of *M. ogilbii*. $\times 25$; d. Pharyngeal bone and teeth of *M. marginatus*. $\times 5$; e. Scale from below base of dorsal fin of *M. marginatus*. $\times 5$.

The question now arises which of the two genera is more primitive—*Matsya* or *Mystacoleucus*? In the case of the Cyprinoid genera it is well recognised that the short anal fin of 5 branched rays is a feature of specialisation, while in the primitive forms, such as *Opsariichthys*, *Chela*, *Barilius*, etc., the anal fin is fairly long. It would, therefore, seem probable on *a priori* grounds that *Mystacoleucus* represents a less specialised form than *Matsya*.

As indicated above the emended genus *Mystacoleucus*, especially the form *M. ogilbii*, shows great affinities with the members of the genus *Rohtee*, and it would be useful, therefore, to examine in the first place the precise limits of *Rohtee* and of its allied genera also.

In the species of *Rohtee* known from India and Burma¹, with the exception of *R. cunma* Day, the dorsal fin possesses a strong serrated spine and the number of branched anal rays varies from 11 in *R. bakeri* Day to 33 in *R. cotio* (Ham.). *R. cunma* was described by Day² from Moulmein and its dorsal fin is characterised by the possession of a "spine

¹ For description of most of the Indian and Burmese species of *Rohtee* see Day's *Fishes of India* and the "Fauna" volumes.

² Day, *Fish. India*, (Suppl.), p. 807 (1888).

weak and longer than the head, not serrated." Unfortunately no specimen¹ of this species is available for study. Vinciguerra², on the nature of the dorsal spine alone, doubted its inclusion in the genus *Rohtee*. Again Tchang's³ separation of his *Parosteobrama* from *Osteobrama* Heckel⁴ (= *Rohtee*) was also based on this feature. Fu and Wang⁵ have, however, shown that Tchang's *Parosteobrama* is in reality *Parabramis* Bleeker and with this view Mori (*op. cit.*) agrees. Mukerji⁶ doubted the advisability of separating *Parosteobrama* from *Rohtee* only on the nature of the dorsal spine. Thus, as in the case of *Matsya* (*vide supra*, p. 312), we have two groups of species in *Rohtee*, those with the dorsal spine serrated (*Rohtee* s. s.) and those with the dorsal spine smooth (*Parabramis*). In most of the species of *Rohtee* the abdominal edge is sharp and trenchant only behind the bases of the ventrals (*Rohtee* s. s.) whereas in *R. belangeri* (C. V.) the whole of the abdominal edge is sharp (*Smiliogaster* (Bleeker⁷)). Similarly among Chinese fishes we have *Chanodichthys* Bleeker,⁸ *Parabramis* Bleeker,⁹ and *Megalobrama* Dybowski¹⁰ which are distinguished from one another by the nature of the abdominal edge. It is thus seen that *Rohtee* and the allied forms constitute a very generalised group showing considerable diversity in form and structure. Ignoring the nature of the abdominal edge and taking into consideration the nature of the dorsal spine, as in the case of *Matsya* and *Spinibarbus*, it may be useful to regard *Parabramis* as a subgenus of *Rohtee* on geographical grounds.

The geographical distribution of the genera *Matsya* and *Mystacoleucus* is very significant. *Matsya* of the *Spinibarbus*-type is known from Formosa [*M. hollandi* (Oshima) and *M. elongatus* (Oshima)], Fukien [*M. caldwelli* (Nichols)] and Hainan [*M. nigrodorsalis* (Oshima)]; while that of the *Spinibarbichthys*-type is found in Hainan [*M. denticulatus* (Oshima)], Szechwan [*M. pingi* (Tchang)] and Tenasserim [*M. argentea* Day]. The members of the two types meet in Hainan, but it may be noted that the forms found towards the west and the south are better armed than those found towards the east. *Mystacoleucus* is found in Siam [*M. marginatus* (Cuv. & Val.), *M. chilopterus* Fowler and *M. atridorsalis* Fowler], South Burma [*M. marginatus* (Cuv. & Val.)], Malay Peninsula [*M. marginatus* (Cuv. & Val.)], Sumatra [*M. marginatus* (Cuv. & Val.) and *M. padangensis* (Blkr.)], Java and Borneo [*M. marginatus* (Cuv. & Val.)] and the Deccan [*M. ogilbii* (Sykes)]. Here again in the more southern forms the dorsal spine is fully armed.

The geographical distribution of the fishes of the *Rohtee* and *Parabramis* groups is also interesting. Species of *Rohtee* are known from

¹ As in the case of *Matsya argentea*, Day's description of this species is based on Tickell's manuscript description and figure. Presumably he had no specimen of *Rohtee cunma*.

² Vinciguerra, *Ann. Mus. Civ. Stor. Nat. Genova*, (2), IX, p. 188 (1890).

³ Tchang, *Bull. Soc. Zool. France*, LV, pp. 46-52 (1930).

⁴ Hora, *Rec. Ind. Mus.*, XXII, pp. 187, 188 (1921), has already explained why *Rohtee* Sykes should have preference over *Osteobrama* Heckel.

⁵ Fu and Wang, *Contrib. Biol. Lab. Sci. Soc. China*, VIII, Zool. Ser. No. 10 (1932).

⁶ Mukerji, *Journ. Bombay Nat. Hist. Soc.*, XXXVII, pp. 69-71 (1934).

⁷ Bleeker, *Nat.-Tijdschr. Neder.-Indie*, XX, p. 428 (1859).

⁸ Bleeker, *ibid.*, p. 432 (1859).

⁹ Bleeker, *Nederl. Tijdschr. Dierk.*, II, p. 21 (1865).

¹⁰ Dybowski, *Verh. Zool-bot. Gess. Wien.*, XII, p. 212 (1872).

Yunnan [*R. belangeri* (Cuv. & Val.), *R. cotio* (Ham.) and *R. microlepis* (Blyth)] and Burma and India (several species, mostly found in Peninsular India). Fishes of the *Parabramis*-type are found in the Amur System, North China, Kiao-Ho, Yangtse-Kiang, Hainan (several species) and Burma (only one species—*P. cunma*).

If the above distributional records are correlated with the extent of the anal fin, we notice that the forms possessing 5 branched rays in the anal fin (*Matsya*) are restricted to Southern China (Formosa, Fukien, Szechwan and Hainan) while one species (*M. argentea*) is also found in the interior of Tenasserim. The *Mystacoleucus*-type, with 8-14 branched rays, is restricted to Siam, Lower Burma, the Malay Archipelago and the Deccan. The *Rohtee*-type (long anal and serrated dorsal spine) is common in Peninsular India, other parts of India, Burma and Yunnan. The *Parabramis*-type (long anal and smooth dorsal spine) is common throughout China and only one species is found in Burma. As indicated above, in the Cyprinoid fishes a short anal fin of 5 branched rays is to be regarded as a feature of specialisation and it would, therefore, seem probable that *Rohtee* and *Parabramis* represent the ancestral forms of the entire group of fishes discussed above. Considering the present-day density of population of the various forms it seems probable that the centre of origin of these fishes was situated somewhere in South China. The diversity of form and specialisation, therefore, seems to have originated in this region and those species that spread towards north and north-west had probably to face less rigorous conditions of existence and did not, therefore, develop fierce, serrated dorsal spine; whereas those that spread towards south and south-west or remained in Southern China had to contend with more disturbed conditions due to the birth of the Himalayan chain of mountains and developed a strong, denticulated spine. *Rohtee cunma*, like *Matsya argentea*, is, however, an exception; it is found in Burma but corresponds to the forms that spread northwards. Its localised distribution signifies that it is a stray element of the northern-type that probably came to Burma with some later waves of migration.

As the ancestral stock travelled towards the south, the number of anal rays became fewer and fewer so that we get the *Mystacoleucus*-type in the Malay Archipelago on the one hand and in Peninsular India on the other. In the case of *Rohtee*, the species with the largest number of anal rays—*R. cotio*—is widely distributed from Southern China to Burma and India; while that with the smallest number of rays—*R. bakeri*—is found in the southernmost extremity of India. The greatest specialisation of all these forms, however, took place in Southern China, their ancestral home, where the fishes of the group possessing 5 anal branched rays, with the exception of *Matsya argentea*, are found today. It may here be noted that these fishes, with the exception of *Rohtee bakeri* Day, are not found south of the Cauvery watershed and neither have they spread to Ceylon or Africa. This point is discussed later (*vide* p. 318).

Many have regarded the predorsal spine as a character of great taxonomic importance, but Rendahl¹, who investigated its morphology,

¹ Rendahl, *Ark. Zool.*, XXIV A, No. 16, pp. 67-74 (1932).

considers it as a feature of convergence. By convergence we usually mean the presence of the same or a similar character in phylogenetically distantly related forms, and further it implies that the character is of special utility to the individuals concerned, for convergence is the result of adaptation of different organisms to a similar type of environmental conditions. In the case of the predorsal spine it is difficult to understand how it can be used as an organ of defence or offence. If, however, the morphology of the dorsal fin of all the forms referred to above is taken into consideration it may be possible to trace its probable mode of origin and to assign to it some definite function.

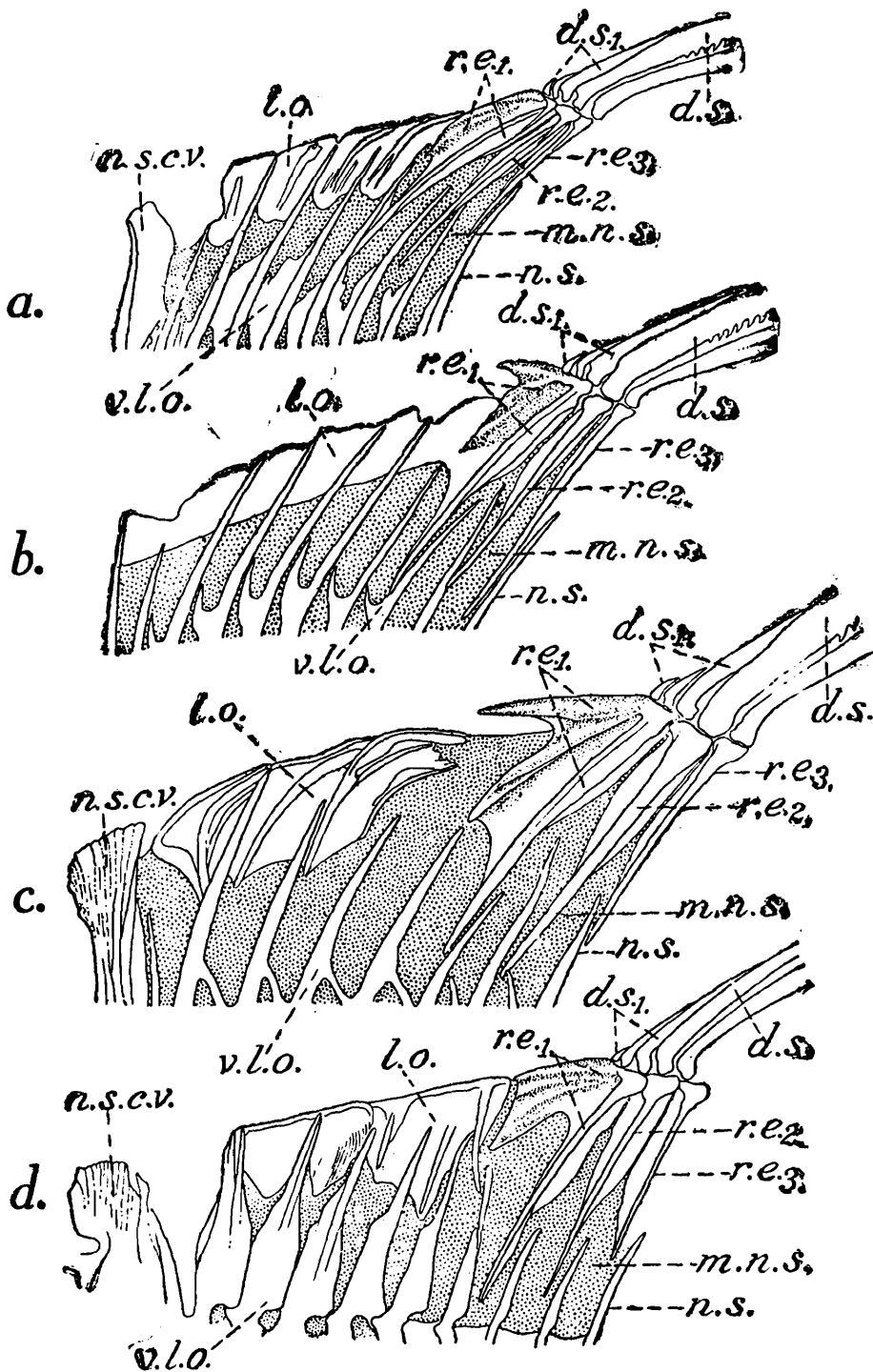
A very characteristic feature of *Rohtee* and *Parabramis* is that both the dorsal and the ventral surfaces are provided with sharp edges—especially the portion of the dorsal surface in front of the dorsal fin and that of the ventral surface behind the ventral fins. To support the sharp edge immediately in front of the dorsal fin the anterior portion of the first radial of the fin (text-fig. 3) is so modified that its distal edge trails close to the surface. In front of the radial elements there is a series of well-developed lamellar ossicles which lie between the neural spines of the adjacent vertebrae; these not only present a suitable surface for the attachment of muscles but also provide the necessary support for the keeled dorsal edge. Anteriorly these ossicles are replaced by the compressed neural spine of the compound vertebra and the supra-occipital crest. Bridge¹ described a similar series of bony elements in *Abramis brama* and *Tinca tinca* and concluded that “These ossicles are proximal segments of the fin supports of the atrophied anterior section of the dorsal fin.” Whatever may be their phylogenetic significance, their presence is undoubtedly meant to provide a support to the sharp dorsal edge.

For the probable mode of origin of the pre-dorsal spine we may consider the structure of the dorsal fin of *Rohtee duvaucelli* (C. V.), *Mystacoleucus ogilbii* (Sykes) and *M. marginatus* (C. V.).

In *Rohtee duvaucelli* (text-fig. 3 a) the character of the radial skeletal elements of the dorsal fin is more or less similar to that of the four Cyprioid types described by Bridge (*op. cit.*) except that its first radial element (*r. e.*) is better developed and its antero-dorsal border lies just below the sharp edge of the dorsal surface. It is preceded by a continuous series of lamellar ossicles (*l. o.*) which lie between the neural spines of the adjacent vertebrae. The median region of each ossicle is thickened to form a ridge-like structure. Near the bases of the neural spines, a further series of lamellar ossicles (*v. l. o.*) is developed from the anterior borders of the neural spines. Anteriorly they become more extensive and form broad supporting laminae between the neural spines. In *R. ogilbii* (text-fig. 3 b) the structures are similar to those of *R. duvaucelli* except that the first radial element (*r. e.*) is produced forward as a short spine, the lamellar ossicles are broad and thin. The ventral lamellar ossicles near the bases of the neural spines have, more or less, coalesced with the spines, so that a forwardly directed outgrowth of the neural spine gives support to the neural spine of the vertebra anterior to it.

¹ Bridge, T. W.—The Mesial Fin of Ganoids and Teleosts. *Journ. Linn. Soc. London (Zool.)*, XXV, p. 549 (1896).

In *R. marginatus* (text-fig. 3 c) the forwardly directed predorsal spine is considerably larger and the dorsal lamellar ossicles are provided with



TEXT-FIG. 3.—The skeletal elements of the dorsal spine and of the region in front of it in Rohtee Sykes, *Mystacoleucus* Günther and *Barbus* Cuvier.

a. *Rohtee duvaucelli* (Cuv. & Val.); b. *Mystacoleucus ogilbii* (Sykes); c. *M. marginatus* (Cuv. & Val.); d. *Barbus kolus* Sykes.

d. s.=Last dorsal spine; d. s.₁=Vestigeal dorsal spines; l. o.=Dorsal lamellar ossicles; m. n. s.=Membrane between neural spines; n. s.=Neural spine; n. s. c. v.=Neural spine of compound vertebra; r. e. 1. to r. e. 3.=Radial elements of the spines and the anterior fin rays; v. l. o.=Ventral lamellar ossicles.

strengthening ridges. The ventral lamellar ossicles are replaced by solid, bony columns between the adjacent vertebrae. Thus in the

three types described above we find that there are bony elements to strengthen the dorsal edge of the fish and that supports are developed to keep the neural spines in position and to prevent them from bending backwards. All these devices are probably meant to combat the stress imposed on the fish as it swims rapidly through water. Under such circumstances the utility of the predorsal spine would seem to present a stream-like wedge to the water before it approaches the dorsal fin. In the earlier stages of the flattening of the keeled dorsal surface it seems probable that more work was thrown on the predorsal spine. This assumption is borne out by the fact that the spine becomes larger and more powerful in the series of forms represented by *Mystacoleucus ogilbii*, *M. marginatus*, and *Matsya pingi*. (The spine of the last species was described and figured by Rendahl). When, however, the entire dorsal surface became stream-lined, the predorsal spine gradually disappeared. Such a course of evolution would indicate the production of "*Barbus*" from *Matsya*-like ancestors. If the presence or absence of a predorsal spine is ignored, *Barbus* and *Matsya* cannot be distinguished from each other by any other well-marked character. There would thus seem to be considerable justification for the views of Nichols and Pope¹ and Nichols² to regard *Spinibarbus* as a subgenus of *Barbus*. In *B. kolus* Sykes (text-fig. 3 d) the neural spine in front of the dorsal fin are laminated in their basal halves and the laminae in some cases overlap one another. The dorsal lamellar ossicles are also well-developed for the attachment of the muscles.

In connection with the above hypothesis, it has also to be considered that *Barbus* is a much more widely distributed genus than the fishes of the *Rohtee* or the *Matsya* groups; it is undoubtedly of great antiquity, as it is found as far afield as Africa. It is possible, therefore, that *Barbus* represents the earliest descendants of the original migrating stock, while *Rohtee*, *Mystacoleucus*, *Matsya*, etc., represent the later waves of migration of a somewhat modified stock which have not been able to reach very distant regions owing to the land connections having disappeared in the meantime.

SUMMARY.

Matsya Day, with 5 branched rays in the anal fin, is recognised as a valid genus and to its synonymy are assigned *Spinibarbus* Oshima and *Spinibarbichthys* Oshima. On geographical grounds, however, species with a serrated dorsal spine are referred to *Matsya* (s. s.) and those with a smooth spine to *Spinibarbus* (subgenus of *Matsya*).

Mystacoleucus Günther, with 8-10 branched rays in the anal fin, is recognised as a valid genus. Owing to the presence of a predorsal spine in *Rohtee ogilbii* Sykes, it is referred to *Mystacoleucus*, the definition of which is emended to include forms with 14 branched rays in the anal fin.

Mystacoleucus, with a longer anal fin, is regarded as more primitive than *Matsya*.

¹ Nichols and Pope, *Bull. Amer. Mus. Nat. Hist.*, LIV, p. 343 (1927).

² Nichols, *ibid*, LVIII, p. 11 (1928).

The inter-relationships of *Rohtee* and *Parabramis* are discussed and the geographical distribution of all the forms referred to above is given. It is observed that the centre of distribution of these fishes has to be placed somewhere in South China whence at different periods different types of forms migrated both towards north and south. The northern forms retained their primitive features while, owing to the orogenic disturbances in South China and further south, the forms migrating towards south and those in the home-country became more highly specialised.

From a comparative study of the skeletal elements of the dorsal fin in 4 forms the probable mode of origin and function of the predorsal spine are given. It is concluded that *Barbus* was probably derived at a very early stage from *Matsya*-like ancestors.