PECTORAL FIN MUSCULATURE IN CERTAIN SILUROID FISHES

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THE anatomy of fishes has always attracted the attention of various investigators. A study of their musculature has however drawn the least attention and very little work is done regarding the study of fin musculature. No doubt a number of workers have investigated the musculature of fins, but a study of the pectoral fin muscles has not been done extensively. Among the earlier workers who studied the pectoral fin muscles include Furbringer (1873, '74, '95), Hartmann (1871, 1872), M'murrich (1884) and others. Unfortunately these papers are not easily available. Shann (1921) in his notable contribution on "The Comparative Myology of the Shoulder girdle and Pectroal fin of Fishes", has given a summary of the work done by the earlier authors and his account gives a fair idea of the work done by these investigators.

The purpose of the present investigations has been to study the muscles associated with the movements of the pectoral fins and find out the part played by each of them. The disposition of the fin muscles of the following three siluroid (Heterognath) fishes, viz., *Macrones cavasius* (Gunther), *Callichrous macrapthalmus* (Blyth), and *Heteropneustes fossilis* (Bleeker), has been therefore worked out.

The nomenclature adopted by the earlier investigators is found to differ very much. Moreover none of the text-books which deal with the anatomical studies of fishes gives a detailed description of the fin musculature; nor there is much uniformity in the nomenclature adopted by the authors of these books.

During the present investigations only the generally accepted terms have been adopted and terminology of Shann (1921) is retained as far as possible. It may be stated here that the terminology adopted by Shann is based on the nature of the development as well as the disposition of these muscles.

In teleosts, the pectoral fin muscles stretch normally in between the cleithrum and/or coracoid bones of the pectoral girdle and the bases of lepidotrichia (i.e. the fin-rays). These muscles are usually divided

further into an adductor and abductor series. The muscles of the adductor series help in bringing in a part or whole of the fin closer to the body. It is observed that the muscles generally associated with the dorsal surface of the pectoral girdle serve as adductors while those which are associated with the ventral surface of the girdle serve as abductors. Further, the adductor muscles may also serve as dilators or constrictors.

All the three siluroid fishes which have been studied here are provided with well developed spines and these are worked out seperately by a special set of muscles, the rest of the fin being worked by another set.

The muscles of the pectoral fins observed during the present investigations may be classified as follows :

The adductor muscles :

1. The adductor *superficialis*,
2. The adductor *profundus*
3. The *dilatator* posterior.

The abductor muscles :

1. The abductor *superficialis*,
2. The abductor *profundus*,
3. The *dilatator* anterior.

The adductor muscles

The adductor *superficialis* :

This muscle arises usually from the dorsal surface of the girdle. It is well developed and towards the origin it may meet its fellow of the opposite side. The insertion is on the ventral knob of the spine. The contraction of the muscle results in the spine being brought closer to the body.

In *Macrones* (Fig. 1) the muscle moves outwards whereas in *Callichrous* (Fig. 2) and *Heteropneustes* (Fig. 3) it moves outwards and backwards.

The adductor *profundus* :

This muscle serves the spine only and has a broad belly. It arises in a fleshy origin posterior to the origin of adductor *superficialis* muscle and the insertion which is tendinous is on the dorsal knob of the spine. By the contraction of this muscle the spine is brought closer to the body.

This muscle arises on the ventral side of the coracoid in *Macrones* (Figs. 1 and 4) and *Heteropneustes* (Figs. 3 and 6) but becomes dorsal in position towards the insertion. In *Callichrous* (Fig. 2) the origin as well as the insertion is on the dorsal side.

The adductor *profundus* of *Callichrous* is actually superficial in position towards the origin. But as it is similar in other respects to adductor *profundus* of other fishes this name is retained to avoid confusion.

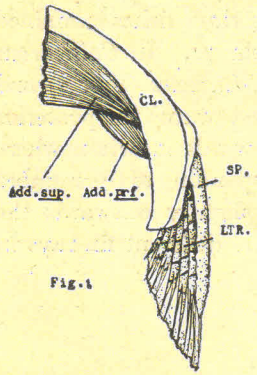


Fig.1

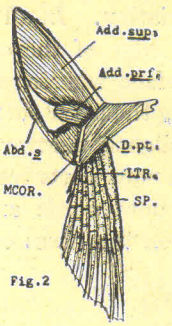


Fig.2

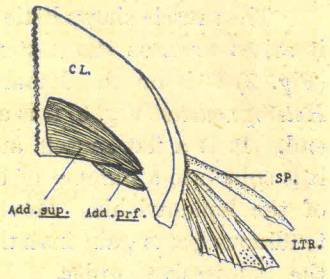


Fig.3

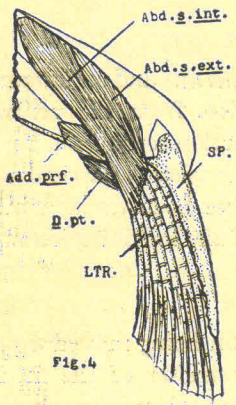


Fig.4

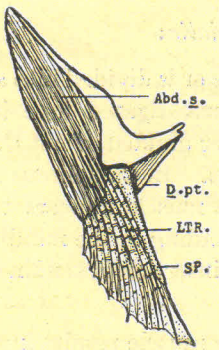


Fig.5

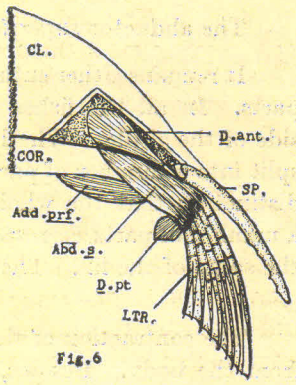


Fig.6

Figures 1—3 The muscles of the fin as seen from the dosral side of the pectoral girdle in *Macrones*, *Callichrous*, and *Heteropneustes* respectively.

Figures 4—6 The fin muscles as observed from the ventral surface of the pectoral girdle in *Macrones*, *Callichrous* and *Heteropneustes*. In Fig. 6 a part of the girdle is cut off so as to expose the *Dilatator* anterior muscle.

Lettering for the Figures

Abd. *prf.*—Abudctor *profundus*; Abd. *s.*—Abductor *superficialis*; Abd. *s.ext.*—Abductor *superficialis externus*; Abd.*s.int.*— Abductor *superficialis internus*; Add. *prf.*—Adductor *profundus*; Add. *sup.*—Adductor *superficialis*; CL—*Cleithurm*; COR—Coractoid; *D.* ant—*Dilatator* anterior; *D.pt.*—*Dilatator* posterior; LTR.—Lepidotrichia; MCOR.—Mesocoracoid; Sp.—Spine.

The *dilatator* posterior :

This muscle also arises posterior to the origin of adductor *superficialis* muscle. Towards the insertion it is further divided into a number of tendinous parts. Each of these tendinous parts is inserted on the lepidotrichia in serial order. The contraction of the muscle moves the various fin-rays (and hence the fin) closer to the body. Besides serving as abductor it also serves as the dilator of the fin by causing the lepidotrichia move away from one another.

The muscle shows little variation. In all the three fishes examined it arises towards the posterior edge of the cleithrum. In *Callichrous* (Fig. 2) it is on the dorsal surface whereas in *Macrones* (Fig. 4) and *Heteropneustes* (Fig. 6) it is along the inner surface towards the posterior end. It is a flat muscle and slightly narrow towards insertion where it is split into a number of tendinous parts corresponding to the number of the lepidotrichia. Moving downwards and slightly outwards the tendinous parts gain insertion on the bases of the different fin-rays in the successive order.

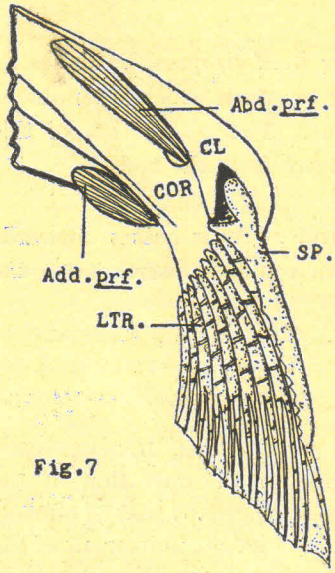
The abductor muscles

The abductor *superficialis* :

It remains either entire or is divided into an *externus* and an *internus* parts. In all the fishes investigated here it arises from the ventral side of the girdle. Whether divided or not the portion serving the fin is split into a number of parts. In Callichrous the division is particularly distinct so that the whole muscle appears to have been divided into a number of parts corresponding to the number of the lepidotrichia and the spine of the fin. The insertion is tendinous.

The contraction of the muscle results in the fin being moved away from the body. Besides, it also acts as the constrictor of the fin in bringing the lepidotrichia of the fins closer to one another.

This muscle is well developed in *Macrones* (Fig. 4) and is divided into an *externus* and an *internus* parts. The origin of the *internus* part is partly from the adjoining portion of the cleithrum, and the origin of the *externus* part is from the cleithrum only. In *Callichrous* and *Heteropneustes* the muscle is not divided into two parts (Figs. 5 and 6). In *Callichrous* it is split into a number of subparts corresponding to the number of fin-rays and the spine and practically covers the entire ventral surface of the girdle. The portion serving the spine is poorly



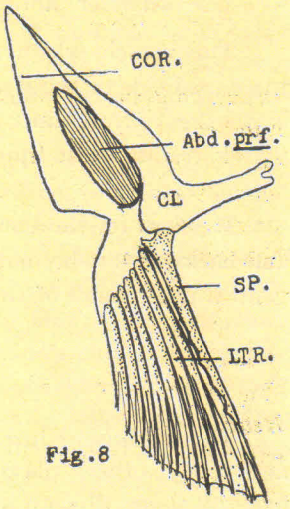


Figure 7 The abductor and abductor *profundus* muscle of *Macrones*
Figure 8 The abductor *profundus* muscle of *Callichrous*

LETTERING FOR THE FIGURES

Abd. *prf.*—Abudctor *profundus* ; Abd. *s.*—Abductor *superficialis* ; Abd. *s.ext.*—Abductor *superficialis externus* ; Abd.*s.int.*— Abductor *superficialis internus* ; Add. *prf.*—Adductor *Profundus;* Add. *sup.*—Adductor *superficialis*; CL—*Cleithrum*; COR—Coracoid ; *D.* adt—*Dilatator* anterior ; *D.pt.*—*Dilatator* posterior ; LTR.—Lepidotrichia ; MCOR.—Mesocoracoid ; Sp.—Spine.

developed. In *Heteropneustes* this muscle is rather poorly developed and does not meet the fellow on the opposite side as is almost the case in the other two species of fishes.

The abductor *profundus* :

This muscle is not observed in all fishes. If present, it arises from the ventral surface of the girdle, and becomes slightly narrow as it passes backwards and outwards. By its contraction the spine moves away from the body.

This muscle which shows little variation was observed in *Macrones* (Fig. 7) and *Callichrous* (Fig. 8) but not in *Heteropneustes*. In *Macrones* the origin is from the ventral surface of the cleithrum as well as from coracoid bone where as in *Callichrous* it arises from the ventral surface of the cleithrum bone.

The *dilatator* anterior :

This muscle which was observed only in *Heteropneustes* arises on the dorsal side of the girdle (Fig. 6). The insertion which is tendinous is on the ventral inner knob of the spine. The contraction of this muscle results in the spine being moved away from the body.

It arises on the dorsal side of the girdle. As it passes outwards and backwards it becomes ventral in position and the insertion is on the ventral inner knob of the spine.

Discussion

The fin musculature of siluroids such as *Macrones*, *Heteropneustes* and many others plays an important role in the operation of the pectoral spine, which is an organ of defence and perhaps that of offence. The well developed knobs towards its base, restrict the movement of the spine and interfere with the free movement of the fin in different planes. Of course individual lepidotrichia are provided with independent sets of muscles and this does confer some freedom on the simultaneous movement of these rays in different directions. Complete removal of the pectoral fins does not seem to affect the stability of the animal. Different species of *Heteropneustes* with their one or both the pectoral fins removed were observed to behave normally for a number of days in the college aquarium. Like other members of the species, not only did they make periodical locomotory movements but also came from the bottom of the aquarium, to the surface—a height of 50 cms.—to breathe atmospheric air. Of course it may be stated here that this is true with many other fishes also and, perhaps there is considerable justification when Schneider and Whitney (1957), state that, if all the fins of a fish are cut off the fish would not be completely handicapped. The fact that in the siluroids studied during the present investigations the pectoral fins are folded back against the body for the most part suggests the correctness of the statement at least in relation to the siluroids and that the fins do not play a prominent role in maintaining the stability. Under these circumstances it is but natural to expect the pectoral fin muscles to play a major role in the operation of the spines rather than in effecting the movements of the fins.

A study of the musculature shows that both the adductor *superficialis* and *profundus* muscles serve only the spine in all the three fishes examined. In a number of fishes however they are observed to serve the lepidotrichia only (Shann—1921).

The dilatator posterior muscles which are not common to all fishes and observed only in few fishes such as *Zeus* (Shann-1921), found in all the three siluroid fishes examined here. These serve both as dilators and adductor muscles as in *Zeus*.

As regards the abductor series, the disposition is similar to that observed in typical fishes. The abductor *superficialis* muscle is split into a number of parts to serve both the fin and the spines in *Macrones* and *Callichrous*, but it serves the lepidotrichia only in *Heteropneustes*. In *Macrones* it is clearly divided into an *externus* and an *internus* parts, the former serving the spine and the latter, lepidotrichia. No distinct *externus* and *internus* parts are observed in *Callichrous*. The muscle in this fish is however subdivided into a number of parts corresponding to the number of lepidotrichia and the spine and the most external part serves the spine as in *Macrones*. In *Heteropneustes* it is poorly developed and does not cover the entire ventral surface of the girdle bones as is the case with *Callichrous* and *Macrones*. The muscle is however split into a number of parts corresponding to the number of lepidotrichia. Thus the abductor *superficialis* muscle showed a great deal of variation in all the three species of siluroids studied.

The abductor *profundus* was observed only in *Macrones* and *Callichrous*. It remained absent in *Heteropneustes*. Instead, in this fish, its function is taken over by the *dilatator* anterior. The last named muscle was observed only in *Heteropneustes*.

The adductor *superficialis* muscle arises from the dorsal side. This confers to the general pattern as observed by Shann and others. The same is not the case however with the adductor *profundus* in *Macrones* and *Heteropneustes*. It arises from the ventral side.

Likewise the abductor muscles generally arise from the ventral side as also observed by Shann and others. The only exception being the *dilatator* anterior of the *Heteropneustes*.

Summary and Conclusions

(1) A study of the disposition of the pectoral fin musculature of three siluroid fishes, viz., *Macrones cavasius*, *Callichrous macrapthalmus* and *Heteropneustes fossilis* has been made.

(2) The study reveals that the muscles can be divided into three main categories, viz., the adductors, the abductors, and the dilator series. The adductors are further divided into a *superficialis* and

a *profundus* parts. The abductors may remain single as in *Heteropneustes* or may be divided into a *superficialis* and a *profundus* parts as in *Macrones* and *Callichrous*.

(3) The *dilatator* anterior which has been described only in few fishes so far by previous workers was observed in all the three siluroid fishes investigated. The *dilatator* posterior, an uncommon muscle was observed only in one fish, *Heteropneustes*.

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