

On the Life-History of the Shanny (*Blennius pholis*, L.).

By

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With Plate XXI¹.

In the life-histories of the British Marine Food-Fishes, published by Dr. Masterman and the author in 1897, it is stated that — »common as this fish (the shanny) is — its eggs have not hitherto received satisfactory attention, probably because they have been difficult to procure, or have not been searched for with sufficient perseverance«. Thereafter² follows a resume of all that was known on the subject at that date. Many efforts have been made — both before and since that date — even to the emptying of the pools and a careful search in every crevice, yet the eggs in their native site have not been obtained at St. ANDREWS. It was not till June 1903 that the first gravid female spawned in confinement, and then, unfortunately, no ripe male was available. In 1904 ripe forms were procured from the middle of April till June, and many eggs were deposited, in glass vessels — where both sexes were congregated, yet all the eggs were either unfertilised or perished shortly after deposition notwithstanding the efforts to preserve them.

The mature female of 4¹/₂ to 5 inches has the lower edge of the pectoral fin tinted in the sunlight of a bluish or whitish opalescence. The edges of the anal rays are yellowish pink, and a similar tint occurs on the edge of the caudal fin. The body and fins generally are marbled and spotted with olive on a greenish yellow ground, and such tints are in harmony with the tangles and other sea-

¹ I am indebted to the Carnegie Trust for the figures illustrating this paper.

² British Marine Food-Fishes, MCINTOSH and MASTERMAN. pp. 206—210.

weeds amongst which they live. As a variety another example from a pool near high water mark was of a dull green throughout.

The external parts of the female are distinguished from those of the male by the shorter distance between the vent and the first ray of the anal, by the large, low cone of the genital papilla with its wide crescentic aperture posteriorly and the small urinary papilla immediately behind it. A conical pigmented flap of skin (with corrugations running to a median groove in many preparations) lies close behind, and apparently supports the first anal ray, but it is a purely cutaneous structure.

The advanced ovaries occupy a large area on each side from the pectorals to the vent, and the size of the eggs is comparatively great. The transverse diameter of the ovaries is greatest dorsally, and posteriorly the organs are somewhat tapered. In transverse section a single longitudinal chamber occurs — leading posteriorly to a bare portion of the ovarian wall in the mid-dorsal region and which is continuous with the genital aperture. In this region the wall of the oviduct (that is the narrower end of the ovary) on each side is marked by longitudinal folds and soon both unite to form the common channel — also marked by five longitudinal creases — in front of the external opening. The ovary — in longitudinal section — forms a long sheet (externally invested by its proper membrane) and thickly covered with ova arranged in a somewhat irregular series of transverse lamellæ, which, however, readily form longitudinal furrows. The inner wall of the organ is more massive, and is covered with deep folds of ovigerous lamellæ which also are mainly transverse in arrangement, but readily form longitudinal furrows here and there especially anteriorly. It would appear, therefore, that this arrangement of folds — all conducting to the central fissure — would conduce to the rapid and safe expulsion of the eggs — the muscles of the body-wall and the fibres towards the termination of the oviduct also aiding in their extrusion. The urinary papilla, sometimes with a central dimple so as to be slightly bifid, lies immediately behind the crescentic upper margin of the genital opening, and in old specimens, as mentioned, a groove with lateral furrows leads from it to the flap in front of the anal fin.

Few previous authors seem to have noted the exact arrangement of the external parts in the male. The authors of the »Scandinavian Fishes«, however, observe »In one of the males we have examined, we found at the beginning of the anal fin a vesiculate dermal

swelling, united to the first ray of the fin and representing the anal papilla¹. This would scarcely suffice for the structure of the parts, for the vent is one of the most characteristic amongst Teleostomi — forming a firm and deep dimple surrounded by a complex series of radiating furrows — often symmetrically arranged. Moreover the space between it and the first ray of the anal fin is greater than in the female. Behind the vent, and separated by a brief interval, is the cylindrical genital papilla which projects freely, and which has a circular terminal aperture, or it may be two (each surrounded by pigment). Another short interval occurs between this and a second papilla which lies at the base of the triangular flap marking the first ray of the anal fin, and it is to this the Scandinavian authors refer. The ureters apparently lead to the aperture at the tip. In this sex the white tips of the anal fin with the dark bar below seem to be more conspicuous than in the female. Further, the anterior rays of the anal fin are considerably shorter and also broader at the base than in the female. The first ray, indeed, forms a short, conical (or triangular) flattened process to which the urinary papilla is attached. Attention has already been drawn² to the almost reptilian or amphibian character of the outline of the testes.

In confinement the eggs were generally deposited during the night either on the bottom of the glass vessel or towards the bottom of the vertical wall. They adhered so firmly that they could not be removed without rupture. The eggs are golden with yellowish pigment, and each has a faintly pinkish disc for attachment, viewed from above (Plate XXI, figs. 1 and 1*A*) each egg is circular in outline with a distinct hyaline zona, the contents (yolk) being dull pinkish or faintly salmon-coloured, though in certain lights the yolk has a dull brownish appearance. The tints are enlivened by a series of bright yellow granules and globules of oil (fig. 1). The diameter of the egg in this position ranges from 1.1811 mm (.0465 in.) to 1.2192 mm (.048 in.). In lateral view (Plate XXI, figs. 2 and 2*A*) the egg forms an oblate spheroid, that is, a sphere flattened at the poles, the vertical diameter being only about .7630 mm, whilst that of the pale pinkish rim beneath is .3048 mm. By transmitted light the eggs have a faint pinkish hue, the minute oil-globules, which vary much in size, forming streaks and groups without definite arrangement. On rupture of the egg

¹ Scand. Fishes, FRIES, EKSTRÖM and SUNDEVALL. Vol. I. p. 215.

² British Marine Food-Fishes, MCINTOSH and MASTERMAN. p. 207.

numerous larger oil-globules are formed by the coalescence of the smaller.

The disc (*d*) attached to one pole of the egg is circular and, when fresh, of a pale pinkish hue, and it is generally slightly larger than the long diameter of the egg. Many of the discs have a finished appearance, as might be anticipated, since they are the product of the ovarian follicles. In others, however, the edge is spongy — with projecting processes. In minute structure the whole is granular, and no special differentiation of the tissue takes place as in the gobies — where the disc of attachment is finely reticulated.

Dr. R. SCHARFF in 1866¹ clearly indicated the peculiarly modified follicle in the ovary of the shanny. He observes »The depth of the cells, which in one half of the egg is only about 0.007 mm gradually increases until it reaches 0.032 mm at the opposite side. The cells at that side become drawn out and taper towards the surface of the egg. The space between the cells is filled with interstitial substance. Another feature about the follicle in this case is that it touches the zona in all parts except in a circular portion where it is not in immediate contact with it. This space is filled with an apparently viscid substance, which is no doubt secreted by the follicular cells.« He mentions that EIMER, BROCK and MCLEOD have observed similar modifications of the follicle. In all probability such is characteristic of those fishes which have an adhesive disc for the attachment of the egg. This special cellular development of the follicle is observed very early in the growth of the ova and it becomes more and more distinct as they enlarge. At the moment of extrusion it probably secretes the viscid amorphous adhesive disc so important for the attachment of the eggs of the shanny to foreign surfaces.

Unfortunately artificial impregnation of the eggs of the shanny has hitherto failed at St. ANDREWS, though so successful in other fishes, and also in various Invertebrates, and thus the development of the egg and the nature of the larval and post-larval shannies cannot at present be given. Indeed it is noteworthy that during all these years of inquiry at St. ANDREWS no larval or post-larval shanny has been seen. They have never been captured in the pools, and have not been met with in the tow-nets or bottom-nets in the bay. They therefore in all probability, either lurk amongst the roots

¹ Proceed. Roy. Soc. Vol. XLI. p. 449 and Q. J. Microsc. Sc. Aug. 1887. p. 19 (sep. copy). Plate V. fig. 15.

of the tangles and Fuci in the pools or in similar quarters just beyond low-water mark. It is usually about the 12th of August before the young shannies (which have passed the post-larval stage) appear in the rock-pools where they have been familiar for more than fifty years. At Naples a corresponding stage is reached earlier in the season, viz. in June, as a specimen kindly forwarded with many other interesting forms by Dr. H. C. WILLIAMSON, shows. Indeed it seems to be an older fish at its length (16 mm) than those procured here in August — probably because the adults do not attain so large a size as with us.

From the 12th of August onward the rate of growth is well shown in the groups which were captured by means of the hand-net in the pools. Thus a single example obtained on the 20th August measured 22 mm. 74 were secured on the 26th August, and of these 1 had reached 26 mm; 16—22 mm; 13—21 mm; 18—20 mm and 12—19 mm. Such proportions show that whilst the bulk of the pelagic forms range between 19 and 22 mm, there is a decided increase in the general growth. On 28th August 50 were captured; 3 had reached 27 mm; 1—24 mm; 9—23 mm; 2—22 mm; 16—21 mm; 15—20 mm and 4—19 mm. The larger forms in all probability gradually left the pelagic series and assumed more or less the habit of the adult; yet, as the season advanced, the increase (in size) of the larger pelagic forms was noteworthy. Out of 41 collected on the 3^d September — 3 reached 27 mm; 2—26 mm; 8—25 mm; 5—24 mm; 4—23 mm; 5—22 mm; 8—21 mm; 5—20 mm and 1—19 mm. On September 6th twenty nine were captured, and of these 1 reached 29 mm; 3—28 mm; 4—27 mm; 1—26 mm; 4—24 mm; 1—23 mm; 8—22 mm; 3—21 mm and 4—20 mm. Eight young shannies procured on September 22^d gave the following measurements: 1—30 mm; 2—28 mm; 2—27 mm; 1—25 mm; 1—22 mm and 1—20 mm. On September 30 the lengths of two were respectively 28 and 30 mm. Small forms still occurred, for on October 7th one measured 19 mm, and another 26 mm. On the 14th December, one of 31 mm was procured; and on the 24th January another of the same size.

On reviewing the various young stages of the shanny in the collection from ST. ANDREWS it is clear that those which occur in June are not of the same season as that of 16 mm from Naples, for they range from 31 to 66 mm, and probably therefore pertain to the young of previous seasons.

When the young shannies first appear in the rock-pools about

the 12th August the smallest is 19 mm in length. It differs from the adult in coloration, proportional length and shape of fins, greater size and more evident separation of the eyes, in the simple papilla of the anterior nostrils and in the more slender and elongated body. At this stage the general coloration is pale greenish intensified here and there with black pigment-specks (Plate XXI, figs. 3 and 3A), the head being most variegated in this respect. Viewed from the dorsum (fig. 3) a conspicuous area of dark pigment occurs over the brain, whilst on each side of the dorsal fin — nearly throughout its anterior two thirds — is a row of bold black pigment-specks. At the anterior edge of the fin is a well-marked patch of small pigment-grains, and two others follow at intervals, so that a character is given to the dorsum. In some these specks are less developed according to the respective age and advancement. In lateral view (fig. 3A) the differentiation just mentioned is less visible. A less distinct row of black specks runs on each side of the anal fin, and a few extend upwards on the sides, but at this early stage they form no definite bands. A few scattered black specks appear on the lips and cheeks — especially in front of the pectorals, and brownish touches occur on the operculum and in the iris. The pectoral fins are faintly greenish in front (externally), but internally (posteriorly) they are boldly marked with black specks which form rows along the interradial membrane, and give a characteristic aspect to the organs. These pigment-specks are largest at the base of the fin — smaller and more numerous distally, though in some a few large specks are continued to the tip. As the fish at this stage is more or less pelagic in the littoral pools, or even with a wider range when the tide is full, this pigment falls into the same category as the bright yellow of the ventral fins of the young ling and the black pigment on the same fins in the young rockling. In the shanny the ventral fins show two rows of similar black pigment-specks — also in the inter-radial membrane, and likewise on their posterior faces. The papilla or flap of the anterior nostril has a shorter broader portion and a longer filiform process; and the posterior border of the pre-operculum has three papillae resembling spines. Parasitic Caligi frequent the posterior surface of the pectorals and other parts at this stage.

Occasionally, when only 1 mm. longer (on the same date, viz 12th August) a decided change in coloration ensues. All the black pigment has disappeared from the interradial membrane of the pectorals. The ventral aspect is pale with the exception of a few indistinct black

specks close to the base of the anal fin, a few touches at the base of the pelvics and on the chin. Six dark patches — some almost cruciform, are now present on the dorsum, the anterior being better marked than the posterior — which are somewhat faint. Touches of pigment also occur along the lateral line, and a few of the original black specks still form a row on each side of the latter half of the dorsal. The head and cheeks are more deeply pigmented, and a touch in a line with the angle of the mouth appears below each eye. The papillæ have disappeared from the posterior border of the preopercular region. The tip of the longer process of the anterior nostril is bifid. In some at this stage a minutely papillose condition of the top of the head is visible in the preparations — probably from the openings of pores.

A survey of the young examples captured on the 26th August shows great variety of pigment. Thus some of the same length as that just described (viz. 20 mm), and which have the six touches on the dorsum, with the lateral and other touches quite as well developed — still retain the black pigment-specks on the interradiial regions of the pectorals and pelvics, and two of the spine-like papillæ are on the preopercular region. The fin-formula is D 12 and 19, A 20. V 3. P. 13. The crown of the head is occasionally almost hispid with minute papillæ, and these may collect grains of sand with mucus. This stage may be represented by a figure from a somewhat longer example — Plate XXI, fig. 4 and 4A. It is not length which necessarily determines the stage which the fish has reached, but the alterations in structure and the state of the pigment.

The chief changes in the next stage are the increase of the dorsal touches especially downwards, and the enlargement of the lateral touches of pigment, the gradual disappearance of the black specks on the pectorals and those at the sides of the anal, together with the absorption of the papillæ from the preopercular region (though one often remains for some time). The tip of the third ray of the pelvics is perhaps more distinct, the bifid papilla of the anterior nostril longer, and the general configuration more resembles that of the adult. The pigment under the chin is more abundant — in the form of two angular bars in front and a longer imperfect one posteriorly. There are about 11 incomplete bars along the sides, and the black pigment-specks have increased on the dorsal and anal fins — chiefly over the rays. It has for the most part left the pectorals; only in a few do some specks remain towards the free edge;

whereas the pigment on the area in front of the bases has increased. Viewed from the dorsum (Plate XXI, fig. 5) seven distinct pigment-touches are visible, but the development of the intervening pigment renders them less isolated. Laterally (Plate XXI, fig. 5A) the dorsal touches are separated from the lateral for the most part — except in the case of the last, and a tendency to a V-shaped form is observed in the first three lateral pigment-spots behind the pectorals — the open end of the V being inferior. The second dorsal is in most the higher fin, and the depression between the divisions is marked. All the fins, indeed, are proportionally large at this stage.

When about 27 or 28 mm long (28th August) the general increase of pigment is marked (Plate XXI, figs. 6 and 6A), the bars and touches on the sides being thus rendered less distinct (or less isolated). No large black pigment-specks occur on the pectorals or ventrals. The V-shaped touches or bars under the chin are conspicuous. The bifid papilla of the anterior nostril is broader, and the shorter more evident. The cheeks are smooth, and the pigment-corpuscles affect the outer or anterior aspect of the pectoral rays — not the interradiial membrane, and the same occurs in the dorsal and anal fins. Pigment is found only at the base of the caudal. At this stage the pelvic fins are of much greater proportional length than in the adult, the extremities of the rays being long, filiform and flexible, the organ pertaining to a pelagic fish, and not yet utilized for support or progression on the bottom.

Before the end of September (e. g. the 22^d) the young shannies (of the lengths given under the date) have the tips of the pelvic fins considerably abbreviated, probably from use on the bottom. This is still more marked in October (7th), and, moreover, injury to these fins would appear to take place not infrequently — one or both being removed or represented only by a stump. It is interesting that on this date (7th Oct.) small examples also occur with black pigment on the interradiial membrane of the pectorals. These probably belong to late broods.

On the 14th December a small example about 1¼ inches in length was procured in a pool. As seen from above six dark touches occur on the dorsum behind the head, and they are also well-marked in a lateral view of the semi-translucent body. A series of white touches adjoining aid in relieving them; and two or three of the anterior touches have a dark pigment-mass below the white and above the vertebral column — which is outlined by the dark pigment above and below it. The sides of the body have a series of some-

what irregular dark blotches. The top of the head has a broad dark bar about half its length, the snout being paler. The eye is flecked with a few touches of white, whilst the pupil is black. Behind the eye is a circular spot — a little less than the eye — surrounded by a white ring with a faintly bluish tint. A few of the same white touches occur on the opercular region and the sides anteriorly. The tip of the snout has a few dark touches, and a reddish-brown one below the eye, and this is continued obliquely upwards and backwards as a band over the eye. The anterior nostril has an inner short flap and an outer (undivided) longer one. Variation thus occurs. The fins have a greenish hue from the yellow and dark pigments. The first dorsal has 12 rays with brownish touches, and the rays of the second dorsal and caudal have also yellow pigment. The pectorals have similar yellow and black pigments; whilst the pelvics are pale with short rays and blunt tips. The two pigments are present on the rays of the anal fin but are less prominent. Much of the alteration in colour is due to the extensive development of the minute black pigment-specks over the whole of the dorsal and lateral regions of the body, over the fins, cheeks, chin and clavicular region. The opening of the mucus-glands of the lateral line are very prominent in the curve at the pectoral. The teeth are well developed and sharp. A similar example (in regard to length and coloration) was procured on the 24th January.

A further stage was met with in June at the length of 1½ inches. The general colour is olive — dappled with black pigment-specks, pale touches and reddish-brown spots. The first four rays of the dorsal fin are marked with reddish-brown. The whitish and brownish touches along the dorsum — on each side of the median fin — are more or less symmetrical. A conspicuous reddish brown spot occurs a short distance behind each eye. The pectorals have the hue of the body, but the pelvics are pale. Small nodules (parasitic) appeared on the rays of the dorsal and caudal fins. Up to this stage the eyes remain proportionally larger than in the adult and more widely separated.

Further stages are seen in shannies of 71 and 85 mm. procured in September (Plate XXI, figs. 7 and 8). In both the eyes are proportionally smaller and nearer each other dorsally than in the previous stages, whilst the general coloration is that of the adult. The tips of the pelvic fins are considerably reduced by their constant use in the support and progression of the animal. The pectorals

are likewise shorter in proportion to the length of the fish. The snout is slightly longer. In one of the examples (fig. 7) the right pectoral has been repaired after injury, and occasionally in confinement caudal and other fins are mutilated by each other.

The hardihood of the shanny in leaving the water and resting on the rocks or amongst seaweeds in the sun has long been known. When their haunts are invaded at low water the fishes leap from the ledges and rock-surfaces into the water. Certain experiences, however, show that their endurance is even greater than what is recorded. Thus a female of $4\frac{3}{4}$ inches, which had only spawned the previous day, was taken to Edinburgh on June 6th in a small quantity of water, and kept in a close chamber all night. Next day it appeared to be dead, but being valuable histologically it was carried to St. ANDREWS amongst sea-weed in a dry vessel. The following day signs of life were observed, and on placing it in sea-water it revived, and lived for a month — until, indeed, it was necessary to examine it. The hardihood of the species is exhibited prominently in other respects, for it can be transferred directly from sea-water to fresh without exhibiting the least inconvenience, and it survives in it for a week or more. In this connection Prof. EDWARD FORBES thought fresh water was so injurious to marine forms that he carried it to sea in order to kill instantaneously *Luidia* which had proved so troublesome by breaking into fragments after capture. Many marine fishes do perish quickly when put in fresh water, and, as elsewhere noted¹, Baltic herrings which have been acclimatised to fresh water die when they are suddenly transferred to sea-water. Moreover COUCH² states that fresh water is fatal to the shanny.

The number of females amongst the shannies seems to be proportionally great, though, perhaps, the older males protect themselves by superior cunning. Thus out of a series of 25 captured in the tidal pools only 8 were males, and all were small, viz. from $2\frac{3}{4}$ to $3\frac{1}{8}$ inches long, yet large males— $6\frac{3}{4}$ in. long—are occasionally obtained³.

The chief constituents of the food of the shanny in a state of freedom amongst the rocks at St. ANDREWS are young mussels and sea-acorns (BALANI); though many small univalves such as *Littorinæ* and adult *Rissoæ*, besides fragments of limpet with the odontophore, are met with.

¹ 3^d Ann. Rep. Scotch Fishery Board. 1885. p. 65.

² Fishes of Brit. Vol. II. p. 228.

³ Life Histories of the Food-Fishes. p. 207.

Explanation of Plate.

Plate XXI.

Fig. 1. Coloured figure of the egg of the shanny seen from above. The disk of attachment (*d*) projects at the circumference. Enlarged.

Fig. 1*a*. The same showing smaller and more scattered oil-globules. $\times 21$ diam.

Fig. 2. Lateral view of the egg coloured from life. Enlarged.

Fig. 2*a*. Structural view of the foregoing with the arrangement of the oil-globules and disc of attachment (*d*). $\times 21$.

Fig. 3. Young shanny 19 mm in length, 26th August. From the dorsum. Enlarged.

Fig. 3*a*. The same in lateral view. In both the large black pigment-specks occur on the posterior aspect of pectoral and pelvic fins.

Fig. 4. Young shanny 25 mm long, 28th August, viewed from the dorsum. Enlarged.

Fig. 4*a*. The same in lateral view. The lateral touches of pigment are indicated.

Fig. 5. Young shanny 28 mm in length, September. Viewed from the dorsum. Enlarged.

Fig. 5*a*. Lateral view of the same. The lateral touches of pigment are more distinct.

Fig. 6. Young shanny, at a further stage, 28th September. Dorsal view. Enlarged.

Fig. 6*a*. The same viewed from the side. The black pigment-specks have disappeared from the posterior aspect of pectoral and pelvic fins.

Fig. 7. Shanny of 71 mm viewed from the dorsum. The right pectoral is abnormal distally — probably from injury. September. Slightly enlarged.

Fig. 8. Shanny of 85 mm. September. Lateral view. Slightly enlarged.



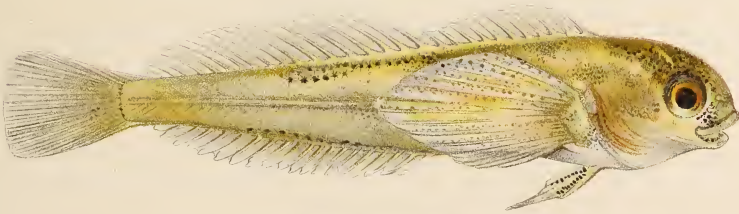


6^A



d

3^A



3





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