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Larvae and Young of the Witch Flounder, *Glyptocephalus stelleri* (SCHMIDT) at Metamorphosis Stages

MUNEO OKIYAMA

I. Introduction

Genus *Glyptocephalus*, once having been a branch of genus *Pleuronectes*, has a single species in the adjacent waters of Japan, that is the which flounder, *Glyptocephalus stelleri* (SCHMIDT). This fish is of somewhat northerly form occurring relatively deep water from the southern parts of Kamchatka including the southern Okhotsk Sea, and far to the south in the neighbouring waters of Chōshi, Chiba Pref. on the Pacific coast and to the southernmost parts of the Japan Sea. It is of great commercial importance to the trawl fishery in the south-western coast of the Japan Sea, and is so abundant there as to exceed 80% of its total landings along all coasts of this marginal sea.

Hitherto, some investigations have been carried out on the age determinations, the breeding habit and the distribution of the which flounder (ISHIDA & KITAKATA 1953, HASHIMOTO 1953; ŌUCHI 1954; and HAMAI & ISHIDO 1958).

So far as the author is aware, however, no investigations have been done on its early life history or metamorphosis in Japan, except for KURAKAMI's excellent research* which reported the embryonic development and newly hatched larvae by artificial insemination (1914). But, DEKHNIK (1959) has recently worked on the early life history of the same species, roughly sketching a few stages of its embryonic development and two individuals situated just before and after metamorphsis, measuring 15.5 mm and 53mm respectively in total length, taken from the southern waters of the Okhotsk Sea.

The present author, of late, could indentify its larvae and young at various metamorphosis stages by the materials obtained from several localities of the Japan Sea.

Before going further, special thank are due to Mr. Rikiichi ISHIDA of Hokkaido Regional Fisheries Research Laboratory for his valuable advice in clarifying the position of KURAKAMI's specimen mentioned. The author wishes to extend his hearty thanks to Messrs.Akira ŌUCHI, Saburo NISHIMURA and Kôsuke NAGANUMA of Japan Sea Regional Fisheries Research Laboratory for their invaluable guidance and assistance throughout

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* The materials used for this survey, were reported under the name of "nameta-garei" in Japanese with the scientific name "*Microstomus kitaharae* JORDAN & STARKS", which was later errorneously referred to *Tanakius kitaharae* (JORDAN & STARKS) by NAKAMURA (1935) and ONDA (1949). However, the close examination by the author of their distributions, spawning habits and local names made it clear that KURAKAMI's materials were synonymous to the witch flounder, *Glyptocephalus stelleri* (SCHMIDT).

the course of this work, and acknowledges his indebtedness to Mr. Hiroshi FUKATAKI of the same laboratory for his willingly giving him a part of his precious materials.

II. Materials and Methods

Six specimens of this fish at various metamorphosis stages were collected from the Japan Sea, over a short period from May to June, 1962, by employing three sorts of sampling gears, viz., 130 cm conical-net (maruchi) towed on the surface; triangular mid-water larval net at various subsurface depths; and the small-sized beam trawl dragged on the bottom. The details of the sampling results are summarized in the following table (Table I).

Table I The collecting data of the witch flounder, *G.stelleri*.

date	time	locality	depth (m)	temp. (°C)	number	range (mm,TL)	net type
V. 1 1962	03.00 - 03.10	38 - 33 N 135 - 40 E	0	11.7	1	19.1	CN
V.16 1962	22.00 - 22.10	40 - 00N 138 - 48E	0	13.0	1	32.2	CN
VI.13 1962	17.35 - 17.45	Sado str.	10	17.9	2	23.3-29.1	TMWN
VI.14 1962	10.50 - 11.20	Sado str.	130	10.6	2	50.2-58.0	SSBT

CN: 130 cm conical net
TMWN: Triangular midwater larval net
SSBT: Small-sized beam trawl

III. Description*

1. Pre-metamorphosis Stage (Fig. 1)

Total length 19.1; standard length 17.2; head length 2.9; horizontal diameter of right eye 0.7; length of snout 0.6; greatest body depth 3.3; body depth at the middle of body 2.0; distance from tip of snout to anus 5.4.

Dorsal rays 92+; anal 76+.

Body very slender and laterally compressed, its greatest depth at the breast with notable downward protrusion of abdomen. Head rather oval, and relatively small, 5.9 in standard length; snout short, approximately equal to diameter of eye; mouth cleft oblique and relativery large, about 2.0 in head length.

Notable development of interspinous zones, characteristic to the larvae of flatfishes, clearly evident. Dorsal and anal, both low and long, membranously connected with caudal in their posterior margins, and poorly developed on both ends in these vertical fins; pectoral transparent, rounded posteriorly, still unprovided with fin rays; ventral lacking entirely.

Myotome obscure, partly distinct on the pigmented parts by the unevenness of the melanophore dispersion on them; body almost colourless, although marked by three notable transverse stripes lying on the trunk: one about the center of the body, another on the base of the caudal peduncle and fin, the last about halfway between the two.

* Measurements of all dimensions are given in mm.

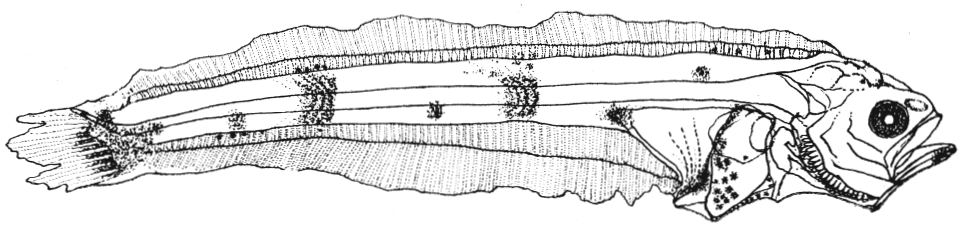

Fig. 1 (T.L. 19.9mm)

Moreover, several pigments dot ventral side of body among three stripes metioned above, tip of the lower jaw, posterior end of abdominal cavity, brain surface, interspinous zones, dorsal part of trunk above anus and surface of abdomen; all fins lack pigmentation completely.*

2. Early Metamorphosis Stage** (Fig. 2)

Total length 23.3; standard length 18.8; head length 4.2; horizontal diamater of right eye 0.9; length of snout 0.9; greatest body depth ?; body depth at the middle of body 3.8; distance from tip of snout to anus ?.

Dorsal and anal rays ?

Body rather elevated coupled with increase in the width of interspinous zones and fins.

Snout pointed bluntly; upper jaw faintly protractile; nostril still a single orifice with a slightly raised rim.

By this stage, the specimen shows a sign of asymmetry in the locality of the left eye.

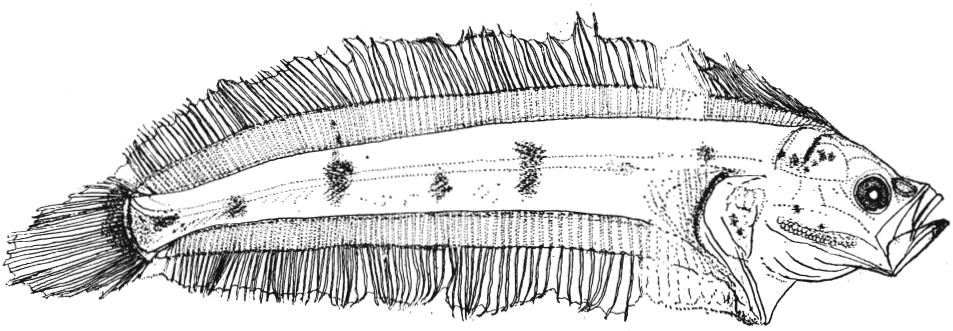

Fig. 2 (T.L. 23.3 mm)

3. Middle Metamorphosis Stage (Fig. 3)

Total length 32.2; standard length 29.1; head length 6.2; horizontal diameter of right eye 1.1; length of snout 1.4; greatest body depth 11.0; body depth at the middle of body 8.4; distance from tip of snout to anus 11.1.

Dorsal rays 94; anal 80.

Body much elevated and abdmen notably protruded, made conspicuous by contrast with the transparency of anal fin and interspinous zones. Head relatively small 4.7 in standard length; left eye moves upward until the upper half of it appears above

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* The newly hatched larvae studied by KURAKAMI (*op. cit.*) show the regular location of melanophores over the fin membranes, but the pigmented pattern in DEKHNIK's smaller specimen of 15.5mm long is entirely obliterated over the marginal fins.

** This specimen was slightly damaged in part of abdomen transversely.

the slightly concaved interorbital; nostrils divided longitudinally into double openings on both sides. Lateral line rudimentary, parallel to body axis, from base of pectoral to posterior of caudal peduncle; scales and teeth still entirely absent.

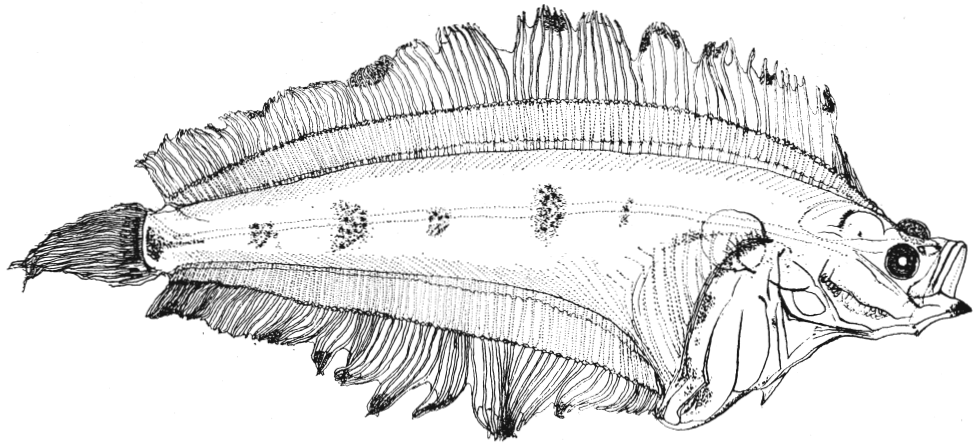

Fig. 3 (T.L. 32.2mm)

Anterior base of dorsal advances over the posterior border of orbit; dorsal and anal with uniform height throughout most of their length, tapering gradually toward head and tail, complete their final numbers of fin rays, remaining small fin folds on both edges of caudal peduncle; ventral very small, located on the anterior margin of abdominal protrusion, with its rays not yet developed.

Myotome, relatively distinct around the boundaries of trunk, arranged in regular succession each having the form of a double chevron fitting one into the other.

Several spots aggregated at intervals, on the edges of dorsal and anal, partly corresponding with those on the trunk, and pigmented areas become narrower on blind side than on eyed side.

4. Late Metamorphosis Stage (Fig. 4)

Total length 50.2; standard length 41.9; head length 9.3; horizontal diamater of right eye 1.9; length of snout 1.5; greatest body depth 14.9; body depth at the middle of body 13.0; distance from tip of snout to anus 13.6.

Dorsal rays 96; anal 83.

Body acquires much resemblance to adult form, while greatest body depth still in the breast. Interorbital region, remarkably concave and left eye migrates just to the dorsal edge of the head; anterior nostrils tubular and located asymmetrically on each side of snout with tip of the blind one visible over dorsal edge of muzzle from the opposite side, while posterior ones, only simple pits located close to the front rims of eyes; mouth small, terminal with feeble denticulation on both sides of jaws; scales have not yet appeared; lateral line continous, with no accessory branches, almost straight, slightly arched at the rear part of the breast.

Origin of dorsal advanced on the hind edge of left eye; ventral completes with six rays in all. Body on the eyed side, marked with five transverse stripes, although partly broken at and near the boundaries of trunk, in addition the paired masses of pigments symmetrical to the lateral axis of body, appear about halfway between them respectively, while last one lacks the dorsal one. Furthermore, rapid increase of pigments over head and marginal fins exclusive of caudal make the contour of

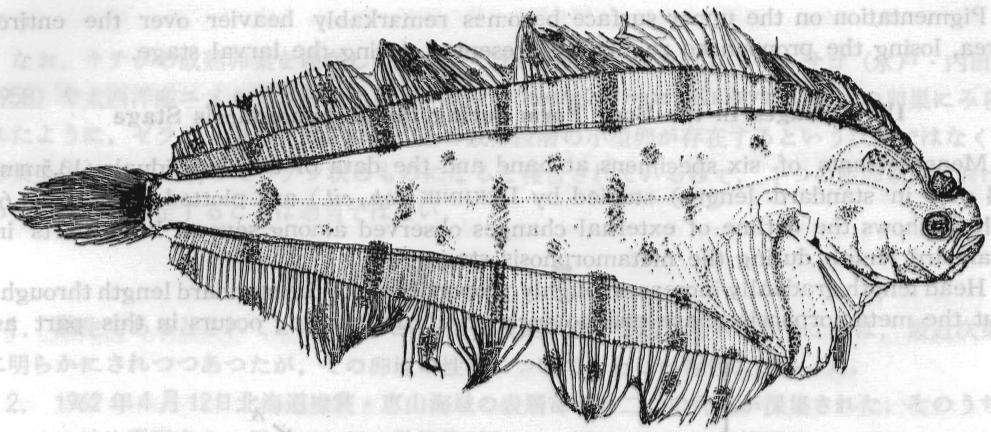

Fig. 4 (T.L. 50.2mm)

this specimen much more clearly. On the contrary, pigments of the blind side fade away leaving a few dots on the trunk at the parts corresponding with large ones on the eyed side.

5. Late Metamorphosis Stage (Fig. 5)

Total length 58.0; standard length 48.2; head length 9.9; horizontal diameter of right eye 2.1; length of snout 1.7; greatest body depth 16.0; body depth at th middle of body 14.9; distance from tip of snout to anus 14.0.

Dorsal rays 100; anal 84.

Left eye nearly completes its migration* to right side and interobital markedly short. Dentition consists of minute and faintly pointed teeth in a single row without any differences in development between eyed and blind sides of both jaws; scales not yet observed; mucous depression on the blind side of head, characteristic to this species, is still indiscernible externally; all fins complete their final numbers by this stage.

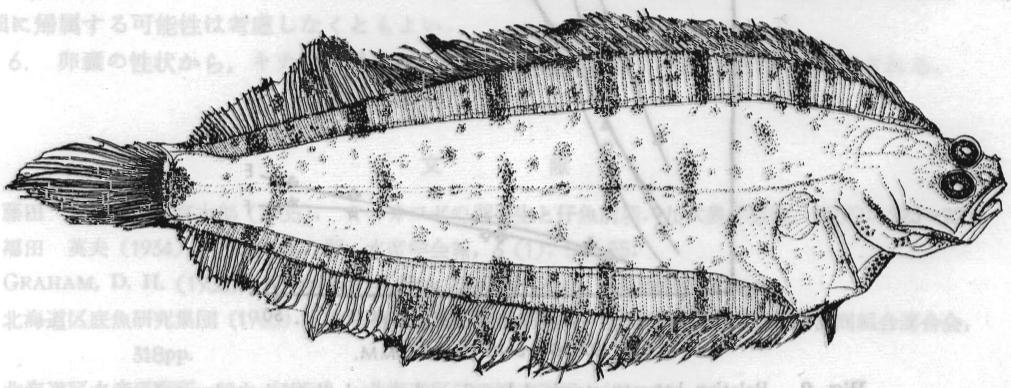

Fig. 5 (T.L. 58.0mm)

* The mode of eye migration observed in this species may fall within the same category as UCHIDA's basic type (UCHIDA 1958), which has been recognized among several Japanese flatfishes, viz., *Pleuronectes cornutus* (T. & S.), *Verasper variegatus* (T. & S.), *Paralichthys olivaceus* (T. & S.), *Pseudorhombus pentophthalmus* GÜNTHER, *Cleisthenes herzensteini* (SCHMIDT) *and Limanda yokohamae* (GÜNTHER).

Pigmentation on the upper surface becomes remarkably heavier over the entire area, losing the pronounced regularity presented during the larval stage.

IV. Changes in the Body Form during the Metamorphosis Stage

Measurements of six specimens at hand and the data of two individuals (13.5mm, 44 mm in standard length) studied by DEKHNIK (*op.. cit.*) are plotted on the Fig. 6, which shows the outline of external changes observed among several body parts in standard length during the metamorphosis stage.

Head length gradually increases roughly proportionate to the standard length throughout the metamorphosis phase and no such an abrupt shifting occurs in this part as

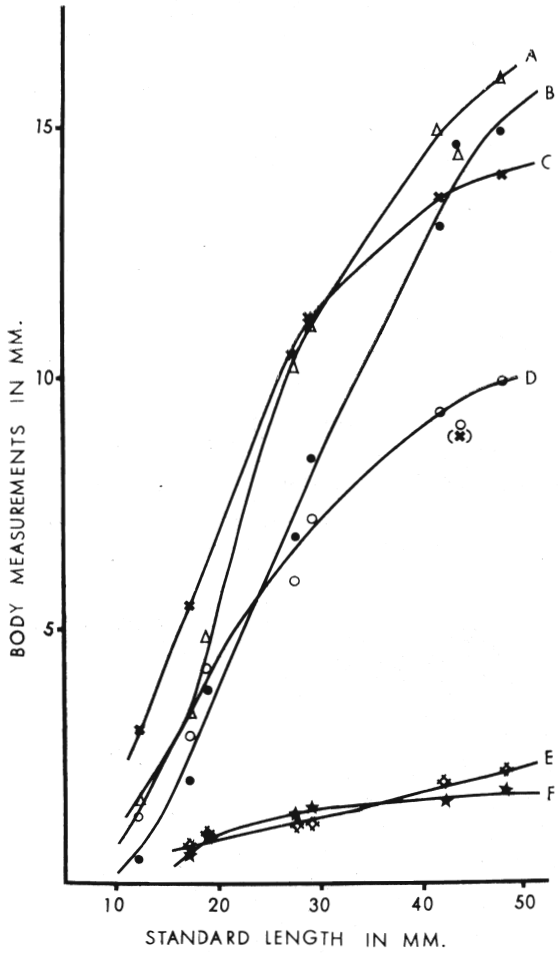

Fig. 6 Relation between standard length and several dimensions denoted by alphabets as follows:

A: greatest body depth
B: body depth at the middle of body
C: distance from tip of snout to anus
D: head length
E: holizontal diameter of right eye
F: length of snout
( ) questionable measurement (after DEKHNIK)

does for the other dimentsions, i.e., greatest body depth, body depth at the middle of body and distance from tip of snout to anus – this last measurement making a sudden degression in the later phase of metamorphosis, probably due to the displacement of anus towards head.

As already mentioned, some dimentions especially body depth, show remarkable growth at the early period of metamorphosis: this phenomenon may have a close relation with the larval adaptation to the pelagic life, namely, to resist sinking by obtaining a large surface relative to its volume, as already illustrated in several species of Heterosomata larvae (UCHIDA 1937). Then, as to the horizontal diameter of right eye and length of snout, only moderate exchanges are shown in the curves.

V. Remarks

In many features of its early life phase, *G. stelleri* is very similar to the Atlantic congener, *Glyptocephalus cynoglossus* LINNAEUS, whose life history has fully been studied (EHRENBAUM 1905, 1936; BIGELOW & WELSH 1925) as shown in the Table 2 giving some comparisons between the two species. As observed in this table, there are striking similarity in total length at every metamorphosis stage surely attributable to the ecological resemblance of both fishes, while a few discrepancies are noticed most remarkably in the egg diameter with the clear inclination of *G. stelleri*>*G. cynoglossus*.

Table 2 Comparison on several features of early life period between *G.stelleri* and *G.cynoglossus*

species	*G. stelleri*		*G.cynoglossus*	
resources	DEKHNIK (1959)	author	EHRENBAUM (1905, 1936)	BIGELOW *et al* (1925)
diameter of egg (mm)	1.22 - 1.54 (1.43)	1.46-1.60*	1.07 - 1.25 (1.16)	1.07 - 1.23
total length of newly hatched larva (mm)	—	4.79 *	Ca. 3.9	Ca. 4.9
range of T.L. during early metamorphosis stage (mm)	—	Ca. 25-	- 25.5 -	Ca. 40
range of T.L. during middle metamorphosis stage (mm)	—	Ca. 30 - 50	—	Ca. 30- 40
T.L. at smallest bottom stage (mm)	- 53 -	- 50.2 -	42 -	Ca. 40 - 50
duration of pelagic life (month)	—	—	—	4 - 6

*After KURAKAMI (1914)
( ) Mean value

Thus, the larvae of *G. stelleri* as well as those of *G. cynoglossus* are suppossed to have a pelagic life of very long dulation as compared with other Heterosomata larvae, although it is dangerous to estimate the dulation of pelagic period with conclusions drawn from the few resemblances mentioned above. And it is of special interest from ecological or phylogenetic points of view that such a cold water inhabitant as the witch flounder produces exceptionally large pelagic larvae or young attaining even about 40 – 50mm in total length, since the occurrenses of the so-called giant larvae in the flatfishes are generally confined to some species belonging to the tropical or subtropical genera, for example, *Bothus*, *Arnoglossus* and *Laeops* (MATSUBARA 1955).

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要　　約

ヒレグロの変態期稚魚について

沖　山　宗　雄

1962年5月～6月にかけてヒレグロの変態期稚魚と思われるもの6個体を採集し，その変態期における外部形態の変化についての概要を知ることができた．ヒレグロ稚魚の特徴は，異体類，中でも北方系異体類としては，例外的に大型の浮游期稚魚—全長にして40～50mm程度になるまで浮游生活を送るであろうと想像される—となることであつて，これはヒレグロの生態および系統上からも極めて興味深いことである．また，この稚魚は，ほぼ無色の体に黒色色素胞を規則的に配列した特徴ある斑紋を形成し，比較的細長い体形と考え合せて，その査定は容易である．なお，4～6カ月の浮游生活期を有するとされる大西洋産の同属種 *Glyptocephalus cynoglossus* LINNAEUS がその初期生活史の種々相でヒレグロとよく類似している点から，ヒレグロも相当長期にわたる浮游生活を送るであろうと考えられることを述べた．

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* in Japanese.