J. Mar. biol. Ass. India, 1969, 11 (1 & 2) : 206-217

REMARKABLE MOVEMENTS OF OIL GLOBULES IN EGGS OF BATHYLAGID SMELTS DURING EMBRYONIC DEVELOPMENT

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The phenomenon of the peregrinating oil globules in eggs of bathylagid smelts during their embryonic development has been known to us for a score of years. I am surprised that the phenomenon has not been described previously. As far as I know, the complex movements of oil globules that occur in a sequential manner during development of bathylagid eggs is without parallel in embryonic development of fishes. The pattern of movement and degree of coalescence of oil globules differ between the two genera of bathylagid smelts, *Bathylagus* and *Leuroglossus.*

Limited information on distribution and relative abundance of larvae of bathylagid smelts in the California Current region off California and Baja California was contained in several of my papers (Ahlstrom, 1959, 1965, 1968, 1969). I particularly have used data from monthly CalCOFI survey cruises made during 1955 to 1960 for making comparisons of relative abundance of larvae of the major families of fishes in the California Current region. Larvae of bathylagid smelts made up about 5% of the total fish larvae on the average, with yearly contributions being as large as 7.5% in 1957 and as small as 2.3% in 1959 (Ahlstrom, 1969). Similar comparisons have not been made on relative abundance of fish eggs in the CalCOFI region, but eggs of *Leuroglossus stilbius* are among the most abundant, exceeded only by eggs of the northern anchovy, *Engraulis mordax*, and the Pacific hake, *Merluccius productus.*

Larvae of three species of bathylagids are commonly taken in the California Current region ; in order of relative abundance these are *Leuroglossus stilbius, Bathylagus wesethi*, and *B. ochotensis.* Larvae of three additional species, *B. milleri, B. pacificus* and *B. nigrigenys* are taken in small numbers. The last species was found to be widely distributed in the eastern tropical Pacific on EASTROPAC cruises.

Of the above species, eggs as well as larvae are known for all except *B. milleri* and *B. pacificus.* In this paper I will discuss development of eggs of the two genera of bathylagid smelts, using material of *Leuroglossus stilbius* and *Bathylagus wesethi,* as representative.

Study material was readily available for making comparative studies of egg development of the three kinds of *Leuroglossus* from the Pacific. Borobulina (1968) recognized three subspecies of *Leuroglossus* : *L. stilbius stilbius* Gilbert, *L. stilbius schmidti* Rass, and *L. stilbius urotranus.* I will use egg size, pattern of embryonic development and some other characters to show that *L. schmidti* (Rass) is indeed a distinct species. I agree, however, with Borobuilina in retaining *L. stilbius urotranus* at the subspecific level.

I would have included information on the embryonic development of eggs of *Bathylagus ochotensis* and *B. nigrigenys* had time permitted.

The eggs of argentinid smelts have only a single large oil globule that remains in a fixed position at the vegetal pole during embryonic development. Eggs and larvae are known for four species of argentinid smelts in the California Current region: *Argentina sialis*, *Microstoma microstoma*, and two species of *Nansenia*. The single oil globule in the eggs of all four species is conspicuously large. These argentinid eggs do share a common feature with those of bathylagid smelts—the shell membranes of the eggs of both families are similarly ornamented with pustules over their inner surfaces. Pustules are somewhat more pronounced on eggs of argentinid smelts than on those of bathylagid smelts. The argentinid smelts also have larger eggs; those of *Microstoma microstoma* ranged between 2.10 and 2.30 mm in diameter, for example.

Development of Eggs of *Leuroglossus stilbius stilbius* Gilbert

Abundant material of eggs of *Leuroglossus stilbius stilbius* was available for study. As noted above, this is one of the three most abundant kinds of fish eggs in

Table 1

Diameter of eggs of Leuroglossus stilbius *from selected localities in the eastern North Pacific and Gulf of California.*

Station	Latitude	Longitude	Date	Number of eggs measured	Egg diameter (mm)	
					mean	range
Pacific Ocean off California and Baja California						
5501– 80.55	34° 19′N	120° 48′W	I–13–55	50	1.15	1.10–1.21
5503– 83.51	33° 52′	120° 08′	III–15–55	50	1.13	1.04–1.20
5501– 83.60	33° 34′	120° 45′	I–14–55	50	1.14	1.08–1.20
5412– 85.45	33° 47′	119° 32′	XII– 4–54	50	1.12	1.04–1.17
5502– 87.35	33° 50′	118° 38′	II–15–55	50	1.10	1.02–1.14
5412– 87.40	33° 40′	118° 58′	XII– 6–54	50	1.12	1.04–1.14
5501– 87.40	33° 40′	118° 59′	I–15–55	50	1.12	1.10–1.20
5503– 87.40	33° 40′	118° 59′	III–15–55	50	1.13	1.04–1.20
5503– 90.37	33° 11′	118° 23′	III–11–55	50	1.12	1.04–1.17
5101– 90.37	33° 11′	118° 23′	I–18–51	100	1.12	1.05–1.20
5501– 90.45	32° 54′	118° 56′	I–16–55	50	1.15	1.08–1.19
5503– 90.60	32° 25′	119° 57′	III–11–55	50	1.13	1.04–1.17
5503– 93.30	32° 50′	117° 31′	III–10–55	50	1.13	1.07–1.17
5501– 93.50	32° 09′	118° 54′	I–19–55	50	1.13	1.06–1.19
5511– Sp.	33° 32′	118° 01′	XI–16–55	50	1.12	1.07–1.20
5501–100.40	31° 21′	117° 27′	I–21–55	41	1.11	1.07–1.21
5501–107.32	30° 26′	116° 11′	I–23–55	50	1.15	1.08–1.20
5504–113.45	28° 51′	116° 17′	IV–15–55	50	1.09	1.06–1.12
5502–117.35	28° 38′	115° 16′	II–18–55	50	1.10	1.04–1.17
5501–117.35	28° 39′	115° 17′	I–26–55	50	1.13	1.05–1.19
5502–117.45	28° 18′	115° 55′	II–18–55	50	1.09	1.04–1.14
5501–120.45	27° 43′	115° 34′	I–27–55	50	1.13	1.08–1.21
5504–120.45	27° 42′	115° 33′	IV–12–55	50	1.10	1.04–1.17
5501–123.37	27° 22′	114° 42′	I–28–55	50	1.14	1.07–1.20
5502–123.40	27° 18′	114° 52′	II–20–55	50	1.11	1.04–1.17
5504–123.45	27° 06′	115° 11′	IV–10–55	50	1.10	1.01–1.20
5404–123.47	27° 03′	115° 20′	IV–14–54	50	1.11	1.01–1.14
Gulf of California						
5602–122G16	27° 40′	112° 28′	II–14–56	50	1.09	1.02–1.14
5602–127G30	27° 03′	111° 48′	II–12–56	50	1.07	1.02–1.16
5602–131G94	27° 00′	110° 24′	II–11–56	42	1.07	1.02–1.14
5602–133G40	26° 16′	111° 04′	II–10–56	50	1.07	1.02–1.13
5602–133G85	26° 38′	110° 22′	II–11–56	50	1.07	1.02–1.12
5602–139G40	25° 24′	110° 32′	II– 9–56	17	1.06	1.02–1.10

CalCOFI collections. Measurements were made on 27 collections of *L. st. stilbius* eggs from the eastern Pacific between Point Conception, California, and Point San Eugenio, central Baja California, and six collections of eggs from the Gulf of California (usually 50 eggs measured per sample). The range in egg size from all collections was from 1.01 to 1.21 mm (Table 1). The mean diameters of the eggs ranged between 1.09 and 1.15 mm for the 27 collections from the eastern Pacific ; no latitudinal or seasonal differences in the average diameters of eggs were evident.

Eggs of *L. st. stilbius* from the six collections from the Gulf of California averaged slightly smaller in size than eggs from the outer coast of Baja California and California ; mean egg diameters ranged between 1.06 and 1.09 mm in the Gulf collections. Even so, there is a striking uniformity is size of *L. st. stilbius* eggs in this rather extensive material from all areas.

L. st. stilbius eggs collected off San Diego on January 3, 1952, were kept alive in the laboratory and observed through hatching. Living eggs are spherical, translucent and clear ; preserved eggs are opaque and lightly coloured. A small perivitelline space intervenes between the outer pustulate shell membrane and the yolk mass with its developing embryo ; the yolk is finely segmented.

The most interesting and unusual thing about the embryonic development of *L. st. stilbius* is the pattern of migration of the oil globules (Fig. 1). Most of the migration occurs during the early stage of embryonic development (before blastopore closure). (I am using the three stages of egg development as defined in Ahlstrom and Counts, 1955.) The newly-fertilized egg has from 15 to 25 oil globules of unequal size, grouped in a loose ball near the vegetal pole. After the initiation of cleavage, there is a migration of the oil globules to a position immediately under the developing blastodermal cap. Simultaneously, the oil globules coalesce into 2 to 5 globules. By the time the germ ring has enveloped the yolk, the oil globules, now two of approximately equal size, have moved to opposite pole positions with respect to an embryonic axis which occupies the equatorial plane. During the middle period of development (from blastopore closure to the time that the separating tail begins to curve laterally away from the embryonic axis), the globules leave their ' polar ' positions and begin to migrate slowly toward the embryo. Pigment forms over the oil globules during this stage, and migrates toward the body at the same rate as the oil globules. During the late period of embryonic development, the oil globules complete the movement to a position on either side of the body, about half way between the head and tail. Before hatching, the oil globules usually move under the embryo and coalesce.

The embryological development of *L. st. stilbius* in other respects is not unusual. The embryo is not as well outlined at blastopore closure as in most fishes. The eyes can be distinguished soon after blastopore closure, however, and myomeres form in middle-stage eggs. The only pigment present on the developing embryo (other than the oil globule pigment already described) is on the terminal portion of the body. It forms on middle-stage eggs and intensifies on late-stage eggs. The pigment outlines the terminal 0.3 mm of the notochord, and extends out into the fin-fold. Before hatching, the free portion of the tail encircles the head ; the fin-fold is wide.

Like most pelagic fishes with small to moderate-sized eggs, the embryo of *Leuroglossus* hatches in a relatively primitive state : the mouth is not formed, the eyes are unpigmented, the pectoral fins are not yet functional. The size at hatching is

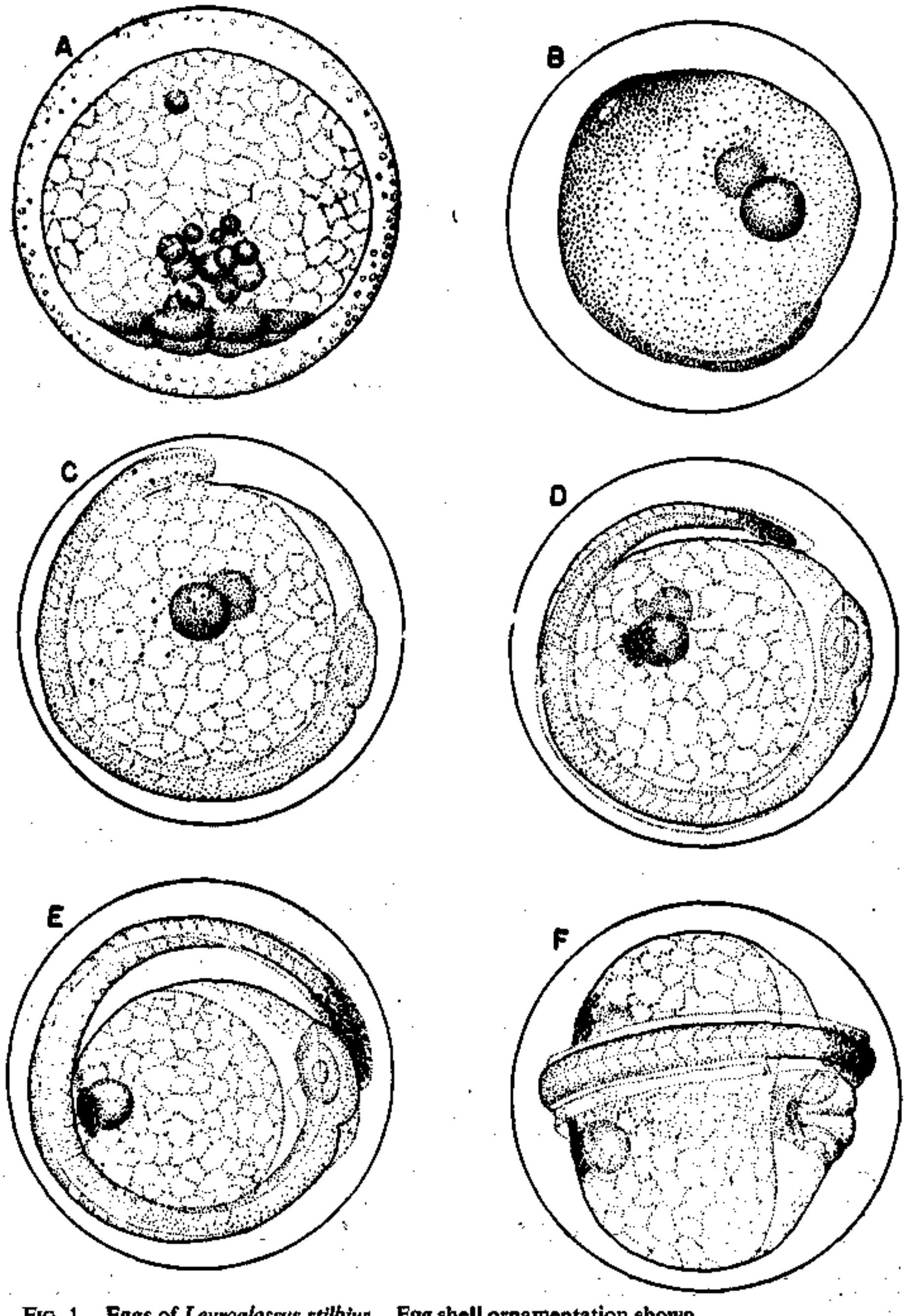

FIG. 1. Eggs of *Leuroglossus stilbius*. Egg shell ornamentation shown.
A. Early stage—16-cell, lateral view.
B. Early stage—immediately prior to blastopore closure, lateral view.
C. Late stage—tail just beginning to separate from yolk, lateral view.
D. Late stage—tail about half developed, lateral view.
E. Late stage—soon before hatching, lateral view.
F. Late stage—soon before hatching, dorsal view.

about 3 mm. The pigmentation on newly hatched larvae is similar to that described for late-stage eggs. The pigment patches previously associated with the migrating oil globules become a single ventral patch located about midway along the digestive tract. Soon after yolk absorption this pigment migrates laterally and becomes a conspicuous lateral dash of pigment on one side of the body only. The spot occurs with equal frequency on either the right or left side of the body. It persists throughout the larval period. The caudal fin-fold pigment decreases in prominence during the early larval period and completely disappears by about 8 to 10 mm in length. Other than to trace the fate of these two pigment areas derived from the embryo, I will not further detail the moderate pigmentation developed on *Leuroglossus* larvae.

Two sizes of *L. st. stilbius* larvae, 5.4 mm and 15.7 mm long, were illustrated in Ahlstrom 1965, figure 1. Larvae have been observed up to 28 mm SL; metamorphosing specimens of *L. st. stilbius* have measured 25 to 29 mm SL. The 28.5 mm individual of *L. st. stilbius* illustrated in Ahlstrom 1965, figure 2, is a late metamorphosing specimen.

Development of Eggs of *Leuroglossus stilbius urotranus* (Bussing)

Size of eggs of *Leuroglossus stilbius urotranus* collected from three localities in the eastern tropical Pacific on Eastropac I are given in Table 2. The range in egg size, 1.03 to 1.21 mm, and the average egg diameter in the three samples, 1.09 to 1.13 mm, are strikingly similar to values given for *L. stilbius stilbius* in Table 1. Not only are the eggs of similar size, but their development is identical in all characters studied. Oil globules move about in an identical pattern to that detailed for *L. st. stilbius*, and the pigmentation developed on the embryo is identical. Because of their marked similarity to eggs of *L. st. stilbius*, eggs of this subspecies are not illustrated.

Larvae of *L. st. urotranus* metamorphose at smaller sizes than larvae of *L. st. stilbius* and develop less pigmentation.

Somewhat greater differences were found between adults of *L. st. stilbius* and *L. st. urotranus*. According to Bussing (1965), adults of the latter have a slimmer body, shorter snout, smaller eye and fewer gill rakers. The two forms also have disjunct distributions. Hence, I will follow Borobulina (1968) in recognizing the southern form as a subspecies of *L. st. stilbius*.

Development of Eggs of *Leuroglossus schmidti* (Rass)

Collections of eggs of *Leuroglossus schmidti* were limited in amount, compared to the abundant material of *L. st. stilbius*; material was available from 12 localities between 46° 28′ and 56° 28′ N and 150° 00′ and 180° W longitude, collected on 'Northern Holiday' Expedition (N.H.) and H. M. Smith (HMS) Cruise No. 30 (Table 3). Eggs of *L. schmidti* range in size from 1.65 to 1.90 mm. The average diameters of eggs in the 12 collections ranged between 1.73 and 1.84 mm.

TABLE II

Diameter of eggs of Leuroglossus stilbius urotranus *from localities in the eastern tropical Pacific.*

EASTROPAC cruise and station	Latitude	Longitude	Date	Number of eggs measured	Egg diameter (mm)	
					mean	range
ETP 14.047	01° 34.5′S	81° 58.5′W	II- 9-67	50	1.09	1.03-1.15
ETP 14.051	03° 08′	81° 55′	II-10-67	50	1.13	1.06-1.20
ETP 14.300	05° 00′	84° 00′	III-28-67	50	1.13	1.08-1.21

TABLE III

Diameter of eggs of Leuroglossus schmidti *from* 12 *localities in the Eastern North Pacific between* 46°-57°*N and* 150°-180°*W*

Cruise and station	Latitude	Longitude	Date	Number of eggs measured	Egg diameter (mm)	
					mean	range
NH sta. 23	56° 28.5′N	151° 39′W	VIII-29-51	4	1.80	1.74-1.85
NH sta. 24	55° 50′	151° 18′	VIII-29-51	15	1.80	1.74-1.90
NH sta. 25	54° 52′N	150° 53.5′	VIII-30-51	6	1.84	1.74-1.88
NH sta. 26	54° 08′	150° 23′	VIII-30-51	5	1.80	1.73-1.90
NH sta. 37	50° 01′	158° 16′	IX- 5-51	7	1.76	1.72-1.79
HMS 30-sta. 38	49° 31′	177° 21′	VIII- 1-55	50	1.76	1.68-1.82
HMS 30-sta. 37	49° 30′	179° 59′	VII-31-55	14	1.77	1.73-1.80
NH sta. 38	49° 01′	157° 55′	IX- 5-51	5	1.76	1.70-1.83
NH sta. 19	48° 48′	150° 00′	VIII-15-51	5	1.82	1.74-1.87
HMS 30-sta. 80	48° 04′	164° 55′	VIII-17-55	5	1.75	1.72-1.80
HMS 30-sta. 35	47° 40′	179° 42′	VII-31-55	48	1.73	1.65-1.80
HMS 30-sta. 79	46° 28′	164° 59′	VIII-17-55	4	1.75	1.70-1.78

Eggs of *L. schmidti* are strikingly larger in size than those of *L. st. stilbius*, which ranged between 1.01 and 1.21 mm in diameter and *L. stilbius urotranus* which measured 1.03 to 1.21 mm in diameter. The difference in size between the smallest egg of *L. schmidti* and the largest of *L. st. stilbius* is 0.44 mm, and the difference between average-sized eggs of the two species is approximately 0.65 mm. Egg size, alone, is sufficient to establish *L. schmidti* as a separate, distinct species.

The fantastic migration of the oil globules in the development of *L. st. stilbius* eggs was described in a previous section. The oil globules perform similar migratory patterns in *L. schmidti*, but with differences in timing (fig. 2). Our material of early stages of *L. schmidti* eggs was inadequate to follow migration in detail, although the general pattern appears to be similar to that described for *L. st. stilbius*. A difference was noted in number of oil globules in precleavage and early cleavage eggs—not more than four or five oil globules having been observed in any of the specimens studied. Two oil globules of about equal size take up positions at lateral poles with reference to the embryonic axis at about the time of blastopore closure. However, the migration from this position toward the body of the embryo occurs rapidly in *L. schmidti*. Soon after the tail begins to separate from the yolk, the oil globules have migrated and fused under the body, and simultaneously pigment has developed between the body and the oil globule. As in *L. st. stilbius*, the pig-

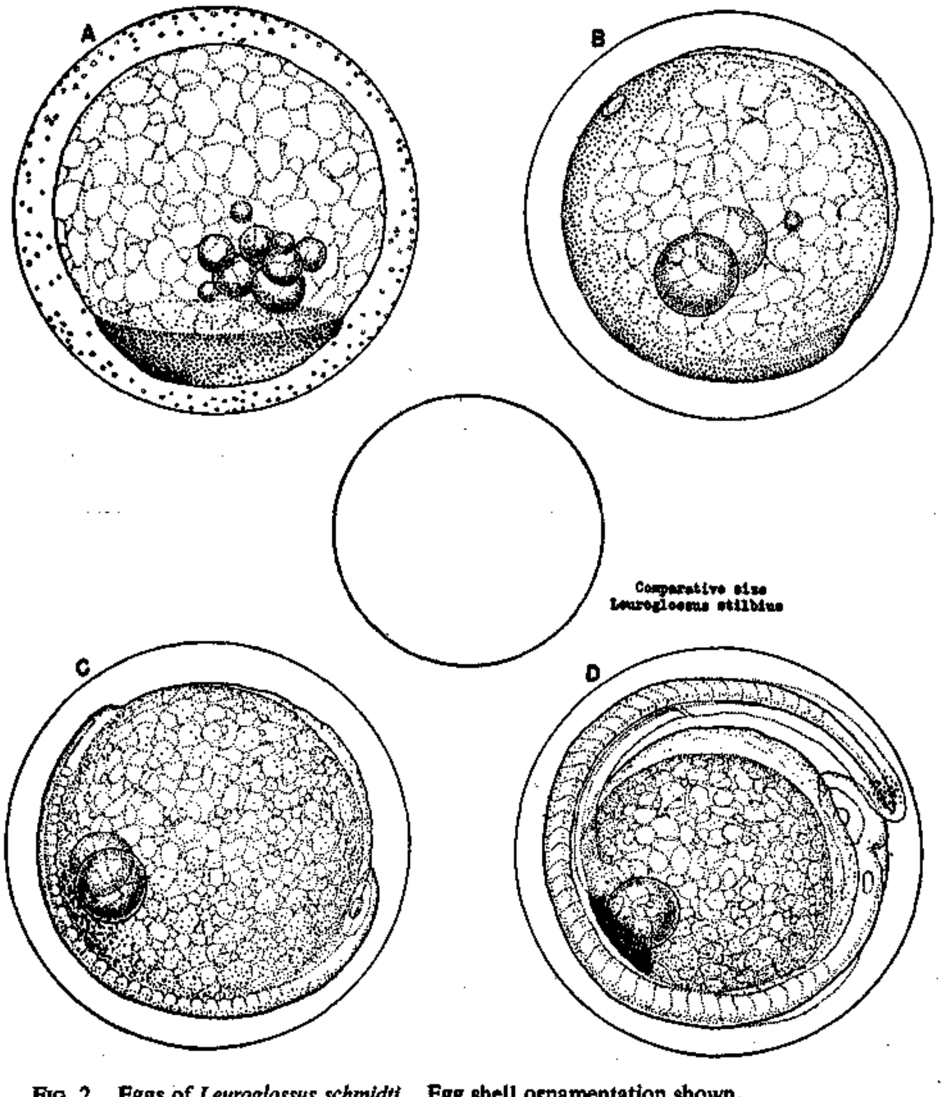

FIG. 2. Eggs of *Leuroglossus schmidti*. Egg shell ornamentation shown.
A. Early stage—blastodermal cap, lateral view.
B. Early stage—immediately prior to blastopore closure, lateral view.
C. Middle stage—near end of stage, embryo well formed, lateral view.
D. Late stage—soon before hatching, lateral view.

ment does not occur on the oil globule(s), but on the yolk membrane above the oil globule(s). Fusions of oil globules occur before the end of the middle stage of embryonic development in *L. schmidti*, whereas it occurs just before hatching in *L. st. stilbius*.

The oil globules are considerably larger in size in *L. schmidti* than in *L. st. stilbius*. At the stage of development when two oil globules are present, they each measured between 0.35 to 0.40 mm, and after fusion up to 0.47 mm, in the material studied.

The pigmentation on the embryo is similar in both species. However, as noted above, the pigment area above the coalesced oil globule is under the body by the end of the middle period of embryonic development in *L. schmidti*, while the two pigment patches above the two oil globules in *L. st. stilbius* remain separate and away from the body until just before hatching. In both species, pigmentation of the embryo is confined to the posterior portion of the body. The pigment area becomes quite intense in *L. st. stilbius*, and considerable pigment extends out onto the fin-fold ; in late-stage eggs of *L. schmidti*, the caudal pigment is less well developed.

Trenchant characters are available for separating *L. schmidti* from *L. st. stilbius* at all stages.

Egg : The egg of *L. schmidti* is about 1.6 times as large as the egg of *L. st. stilbius*. There is a different pattern in migration of the oil globules during embryonic development.

Larvae : The larva of *L. schmidti* has a 20% greater number of myomeres, and of vertebrae when these develop—49 to 52 as compared to 39 to 42. It has a considerably greater development of larval pigment and somewhat different body proportions, including a shorter head, smaller eye and lesser depth of body.

Juvenile-adult : The most marked differences in meristics is in the number of vertebrae, as noted above. Borobulina (1968) pointed out a number of morphological differences, and especially called attention to the relation between the length of the caudal peduncle to its depth as a diagnostic character for readily separating the two species.

Although Borobulina retained *schmidti* as a subspecies of *L. st. stilbius*, she noted the possibility that in the future it may be ranked as a separate species. I have supplied information that should remove any doubts about this being a separate species. A question does remain as to the specific name to apply to this species. The skeletalized species of fish described from fur seal stomachs by Lucas in 1899 as *Therobromus callorhini* is a bathylagid, as was shown by Chapman (1943). It almost certainly is this species (Ahlstrom, 1968). However, until supporting evidence has been carefully prepared to support this attribution, it seems preferable to retain the name *L. schmidti*. I do not consider this paper the proper forum for presenting such evidence.

Development of Eggs of *Bathylagus wesethi* Bolin

Information on size of eggs of *Bathylagus wesethi* from 10 localities in the California Current off northern and central Baja California is contained in Table 4. The eggs ranged in size from 0.90 to 1.07 mm ; mean diameters of eggs in the 10 collections ranged from 0.94 to 1.01 mm. Eggs of *B. wesethi* were noticeably smaller than those of *Leuroglossus stilbius* in collections containing both. This is the most common species of the genus *Bathylagus* taken in the California Current region (Ahlstrom, 1969).

Development of *B. wesethi* eggs is illustrated in figure 3. The deployment of oil globules in eggs of *B. wesethi* during embryonic development is similar to the pattern observed in eggs of *B. ochotensis* and *B. nigrigenys*, hence may be represen-

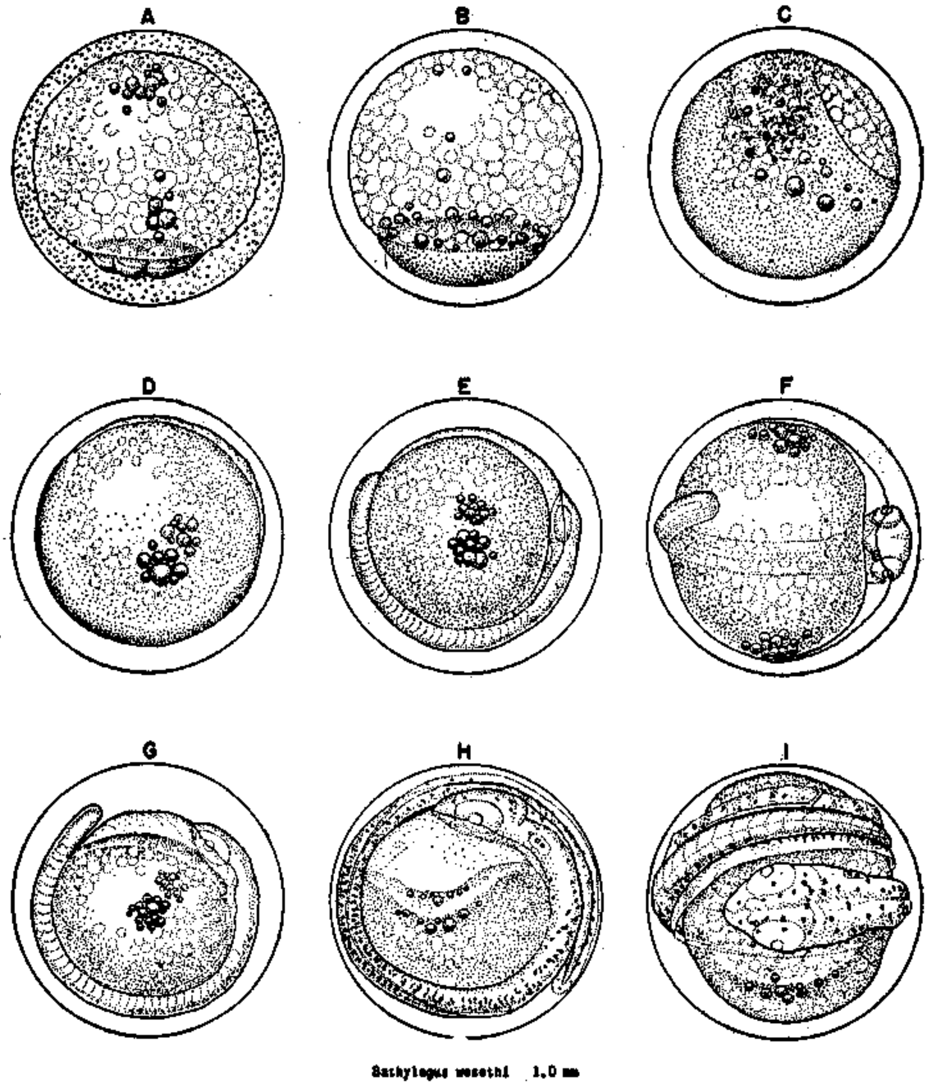

FIG. 3. Eggs of *Bathylagus wesethi*. Egg shell ornamentation shown.
A. Early stage—8-cell, lateral view.
B. Early stage—blastodermal cap, lateral view.
C. Early stage—germ ring 5/6ths around yolk, lateral view.
D. Middle stage—soon after blastopore closure, embryo poorly defined, lateral view.
E. Middle stage—near end of stage, embryo well formed, lateral view.
F. Late stage—soon after tail has begun separation from yolk, dorsal view.
G. Late stage—same, lateral view.
H. Late stage—immediately prior to hatching, lateral view.
I. Late stage—same, dorsal view.

tative of the genus as a whole. The pattern differs in several important respects from that described for *Leuroglossus* eggs. The oil globules move from the vegetal pole soon after fertilization, as in *Leuroglossus*, but they take up positions around the periphery of the blastodermal cap, not underneath it. In *B. wesethi* this ring is made up of a fairly large number of subequal oil globules, usually 12 to 20. The oil globules maintain this position until the germ ring has covered about 2/3 of the yolk, then collect into two ' polar ' clusters at right angles to the axis of the developing embryo (as in *Leuroglossus*).

TABLE IV

Diameter of eggs of Bathylagus wesethi *from selected localities in the California Current region off Baja California.*

CalCOFI cruise and station	Latitude	Longitude	Date	Number of eggs measured	Egg diameter (mm)	
					mean	range
5504–100.90	29° 45′N	120° 04′W	IV–20–55	50	0.97	0.90–1.07
5504–103.65	29° 57′	118° 44′	IV–21–55	50	0.97	0.90–1.02
5504–107.50	29° 51′	117° 20′	IV–17–55	50	1.00	0.94–1.06
5504–107.60	29° 31′	118° 02′	IV–17–55	50	1.01	0.96–1.06
5504–107.80	28° 51′	119° 24′	IV–17–55	50	0.96	0.90–1.00
5504–110.80	28° 16′	118° 56′	IV–16–55	50	1.00	0.95–1.07
5503–117.55	27° 58′	116° 33′	III–18–55	50	0.94	0.90–1.00
5503–120.55	27° 20′	116° 08′	III–21–55	50	0.97	0.90–1.02
5503–120.60	27° 12′	116° 28′	III–20–55	50	0.96	0.90–1.00
5503–120.90	26° 13′	118° 30′	III–20–55	50	0.96	0.90–1.02

Throughout the remainder of the embryonic period the oil globules retain these positions. The oil globule may partially coalesce, but never completely. In some eggs they appear to be gathered into a compact cluster at either pole, in others they are more widely separated. A major difference between the deployment of oil globules in *B. wesethi* eggs and those of *Leuroglossus* is that the oil globules do not move toward the embryo as happens in *Leuroglossus* eggs. Also there is no formation of pigment over the globules.

As in *Leuroglossus*, the embryo is not as well outlined at blastopore closure as in most fishes. Pigmentation also develops late. It is first evident in late-stage eggs soon after the tail portion of the embryo becomes separated from the yolk. Pigment develops dorsally on a group of 10 or so myomeres immediately behind the head. It gradually spreads posteriorly and also anteriorly on the head. It reaches its full development, however, only immediately before hatching, at which time it extends dorsally from the snout to the end of the notochord and extends out into the wide dorsal fin-fold along much of the length of the embryo and in the posterior part of the ventral fin-fold. This intense development of pigment is in marked contrast to the paucity of pigment in *Leuroglossus* eggs.

The embryo of *B. wesethi* hatches in a rather primitive state, as has been noted already for *Leuroglossus* embryos. The embryonic pigment on the newly hatched embryo is markedly different from that found on early stage larvae of *B. wesethi*, hence the yolk sac stage is a time of pigment migration and rearrangement. The predominantly dorsal pigment of the embryo is transformed into the characteristic ventral pigment pattern found on early stage larvae. It would be difficult to find a more striking example of the magnitude of this change than that which occurs during the yolk sac stage of *B. wesethi.*

The only conspicuous dorsal pigment that remains in early stage larvae is a dash of pigment near the tip of the notochord that is matched by an opposing ventral pigment dash, as shown on the 5.7 mm specimen illustrated in Ahlstrom, 1965. Pigment remains in the ventral fin-fold, especially under the posterior third of the intestine. Dorsal fin-fold pigment usually is lacking in small larvae, but gradually reappears in middle and late-stage larvae. Larvae of *B. wesethi* gradually become quite heavily pigmented, as is shown in illustrations of 11.3 and 24.5 mm specimens in Ahlstrom, 1965.

It should be noted that some features of larval development of bathylagid smelts are almost as unusual as those described for embryonic development. The most striking of these is the manner of formation of the dorsal and anal fins. The dorsal fin forms near the outer edge of a wide fin-fold, the anal fin forms obliquely in the ventral fin-fold, somewhat closer to the body. Both fins are attached to the body by 'streamers.' These fins are brought adjacent to the body at the initiation of metamorphosis. The brief metamorphic stage is a period of transition from larval characters to those of the juvenile. In bathylagid smelts, rather marked changes in body proportions occur during metamorphosis, and fins complete formation of ossified rays.

Summary

The complex movement of oil globules that occurs in eggs of bathylagid smelts during their embryonic development is, as far as I know, unique to this family.

Observed differences in the movements of oil globules in species of the two genera of bathylagid smelts lend additional support to the validity of *Leuroglossus* as a genus distinct from *Bathylagus*. Hence the peregrinating oil globules of *Leuroglossus* can join the lack of an orbitosphenoid bone (as reported by Borobulina, 1968) as trenchant characters supporting its validity as a genus.

Acknowledgements

I wish to acknowledge my appreciation to Daniel Cohen for help in identifying adults of bathylagid smelts, and for his contagious interest in this fascinating group of fishes. Help in assembling material and making measurement on eggs and larvae of *Bathylagus* and *Leuroglossus* was given by Robert Counts, Amelia Gomes, Lois Hunter, Elaine Sandknop, and Elizabeth Stevens. The illustrations were prepared by George Mattson.

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