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THE EGGS AND EARLY LARVAL STAGES OF
THE AUSTRALIAN PILCHARD—SARDINIA
NEOPILCHARDUS (STEIND.).

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(Plate xvi, and Figures 1-4.)

One of the most important of the scientific fishery problems to be undertaken in
Australian waters is the recognition of the pelagic fish eggs and larvae (more especially
those of commercially important fish) and their seasonal and geographical
distribution. It has taken many years to achieve a working knowledge of the
fish eggs and larvae of the North Sea, yet that is a well-defined and almost closed
area, which is inhabited by large numbers of a reasonably small list of fish species.
In comparison the work to be carried out in the coastal waters of New South Wales
alone may prove much more difficult. With a fish hatchery in working order
it would be possible to make certain of the characters of the eggs and early larvae
of at least some of our important fish species. Unfortunately, so far as this is
concerned, fish hatcheries for marine fish species are not particularly favoured by
experts to-day, but marine laboratories would make it worth while to attempt
the hatching and rearing on a small scale. Eggs can also be pressed from ripe fish
on board a trawler and sperm obtained in the same way. That fertilization can be
achieved with the simplest apparatus in this manner in Australian waters has already
been proved by the authors.

Another method of determining the species of fish eggs and one of wide
application, although necessitating time and patience, is that of collecting both
eggs and larvae by the utilization of coarse meshed plankton nets at sea. These
eggs and larvae are sorted out and the different stages fitted together until examples
are obtained possessing characters sufficiently marked to indicate the identity
of the mother fish. The present paper is concerned with the discovery of the eggs
of the pilchard by this means.

Plankton nets suitable for the capture of fish eggs have been used regularly
during the past two years at a spot about four-six miles east of Sydney Heads. Many
different kinds of eggs have been captured during this period. Amongst these
the type of egg figured (Figures 1-3) was found to be particularly abundant in three
successive years during the months of June, July and August. The egg averages
1-4 millimetres in diameter and is marked by a segmented yolk and a wide
perivitelline space. The general appearance of the egg at once suggested that it was
one belonging to some species of the herring group (family Clupeidae). But although
we were struck at the outset by a resemblance to the egg of the European pilchard,
we hesitated to accept it as a pilchard egg in view of the presence of several clupeid
species, to which it might have belonged, in our waters.
Delsman at Batavia found no less than six different kinds of eggs of Clupeids all of the same type as the Sardine or Pilchard egg of Europe—that is, possessing a segmented yolk and a wide vitelline membrane. It was obvious that with several unknown clupeoid possibilities in these waters it would be rash to claim the mere general resemblance to the European pilchard egg as sufficient evidence of identity.

During the year 1933 the eggs first turned up in our catches late in the month of May, and as they were present in considerable numbers a special effort was made by weekly expeditions to obtain later and later larval stages. We were very successful in this, and for five or six weeks the larval were collected, larger ones being present in the later hauls until, at the beginning of August, they disappeared. The largest specimen obtained measured 28 mm. in length. This specimen set aside our doubts about the species, for whilst counts of the myotomes had shown an equally possible diagnosis as pilchard, sandy sprat, or blue sprat, the character of the dorsal fin settled the question. The eggs and larval were accounted definitely to be those of the Australian pilchard (Sardinia neopilchardus Steind.).

The Egg.

The eggs are slightly smaller than those of the European pilchard—Clupea pilchardus, and the Japanese sardine—Clupea melanosticta Schlegel. The diameter of the eggs of the former is 1·5 to 1·8 mm. and of the latter 1·5 mm. The mode for the eggs of the Australian pilchard in New South Wales waters is 1·44 mm., but they range from 1·27 to 1·5 mm. in diameter. The diameter of the yolk is only 0·75 to 0·8 mm. There is a distinct bluish tinge to the vitelline membrane which in some cases approaches a red tint. The effect is, however, purely optical.

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1 Delsman.—"Fish Eggs and Larvae from the Java Sea." No. 7. p. 218. Treubia, viii, 3-4, July, 1926.
3 Ehrenbaum.—"Eier und Larven von Fischen" in Brandt und Apstein, Nordisches Plankton, 1, 2, 1909.
and not due to the presence of pigment. It disappears when the membrane is
dissected away from the egg. A single small oil globule is present as in the European
and Japanese pilchard eggs.

The segmentation of the yolk is that characteristic of clupeids and is probably
due to the intermixture of cytoplasm and yolk. There seems to be some indication
that the separate spherules become larger as the egg develops. Usually all stages
of development are found in one catch of eggs and, although no indication of the
exact duration of development has been obtained, it may be suggested as not more
than two days in the New South Wales coastal waters at 17°C, since the European
pilchard egg hatches in four-five days at 9°-12° and the Indian clupeid egg takes
less than 24 hours. Already before hatching one other clupeid character can be
noted—the anus of the tiny embryo is far posterior in position (see Figure 4).

No pigment is present in the eyes or elsewhere at hatching time.

The newly hatched larva is 2·5 mm. in length. Large numbers of individuals
were captured at this stage each year—it was the later stages that were more
difficult to obtain.

![Figure 4.](image)

Newly hatched larva of *Sardinia neopilchardus*, Steindachner, 2·5 mm. Note yolk sac and oil
globule, also anal aperture near posterior end.

The remains of the yolk are to be seen appended to the larva (Figure 4); the
oil globule is still present and posterior in position. As yet no pigment is present
anywhere. A characteristic criss-crossing of the muscle fibres of the myotomes
may be noted at this stage; it is figured for the much larger larva of 15·6 mm.
(Pl. xvi, fig. 3). At the 2·5 mm. stage the anus lies under about the 42nd myotome.

The yolk sac is still visible when the length of 4·5 mm. is attained (probably
2-3 days after hatching) but the yolk has now disappeared. The most difficult
or crucial period for the young larva has arrived and further development will
depend not only on its luck in surviving enemies but on the presence of a suitable
supply of microplanktonic plants and animals on which to feed.⁴

The rudiments of the fins may be noted at the stage just mentioned—the first
to appear being the pectorals. The intestine also begins to show a characteristic
folding (very distinctive of the larva of Clupeid fishes) at the length of 4·5 mm.

The embryonic condition of the tail is still a feature of the embryo, but signs
of the ventral lobe of the caudal fin are to be seen at the 4·5 mm. stage. The dorsal

⁴ One larva of the length of 11·5 mm. (Pl. xvi, fig. 2) contained a newly captured copepod in its stomach.
This turned out to be *Paracalanus parvus*, one of the most common species in New South Wales coastal waters.
fin is first visible in our larvae when the length of 7.5 mm. is reached (Pl. xvi, fig. 1). It is probably present before this, but we had no stage corresponding to a 6 mm. length. The anal fin appears when a length of 12.7 mm. is attained. The pelvic fins do not appear until later when the length of 18 mm. is reached.

Pigment has made its appearance when the larva is about 8 mm. in length. It develops first in the eyes, although at this stage a few chromatophores may also be seen along the ventral margin of the larva.

At a length of 8 mm. the tail shows a distinctly heterocercal character, but the hypural region is developing, and in the subsequent stages the ventral lobe becomes longer and the dorsal reduced, although at 15.5 mm. the dorsal lobe is still present (Pl. xvi, fig. 3).

At an early stage, say 3 mm., it is possible to count 40-42 myotomes in front of the anus, and whilst the number behind is not so distinct it is at least 10. Actual counts of the vertebrae in adult specimens of the Sandy Sprat (Hyperlophus vittatus Castelnau), Blue Sprat (Stolephorus robustus Ogilby) and Pilchard (Sardinia neopilchardus Steind.) give 46 for the first named and 45 for the last two. There is little diagnostic information, therefore, to be gained from those counts in the larva, except to exclude some other possible species. (The number of the vertebrae in the Australian Herring, Harengula castelnaui (Ogilby) is 39.)

The 15.5 mm. larva (Pl. xvi, fig. 3) presents well developed hypurals and the caudal fin is approaching the homocercal type, although a distinct separate dorsal portion is to be noted as already mentioned. The dorsal fin is now considerably developed and shows upwards of 16 fin rays—an important point as will be noted below. The anal fin is also well developed, but there is still no trace of the pelvic fins. There is now a series of chromatophores along the body next to the ventral edge, extending from the operculum to the point where the folding of the intestine is to be noted. From this point deeper lying chromatophores can be seen, presumably in the wall of the abdominal cavity.

The latest stage captured is that of 28 mm. (Pl. xvi, fig. 4). At this stage the pelvic fins are easily seen, and there are eighteen or nineteen fin rays in the dorsal fin. This in itself cuts out the other possible clupeoid species of our shores. It is a noteworthy fact that the dorsal fin is far posterior and well behind the pelvics, although in the adult the position of the dorsal fin is more nearly midway between head and tail. It is evident that during later development the position of the dorsal fin must move forward. Exactly similar conditions are met with in the development of the European pilchard.

At the 28 mm. stage there are about 38 myotomes in front of the anus (the number is less than at the 8 mm. stage). The tail fin has lost the dorsal lobe and is already homocercal in type with incert middle part giving a bifid appearance. The chromatophores are, as before, a series at the base of the body especially between the head and pelvic fins and between the anus and caudal fin, and in addition there are the abdominal pigment spots associated with the alimentary canal region.

The number of eggs and larvae captured has at times been considerable. Thus, in a net of cheese cloth with a circular mouth 3 feet in diameter and towed for only 10 minutes near the surface, 406 eggs of Sardinia neopilchardus were obtained on 18 July, 1931, and over a thousand in a similar haul on 21 June of that year.

It is fair to assume from the facts now set forth that very considerable numbers of Australian pilchards must be present off the coast of New South Wales during
the months of May or June to August, and indeed this fits in with the statements of fishery inspectors and of men on board trawlers, who have seen them from the deck. It has now been definitely established that the fish are breeding during these months. The characters of the eggs and larvae have been set out and figured.

These facts should be of the utmost importance in view of the demand for some scientific data regarding the occurrence and migration of our pelagic fish and the possibilities of their exploitation.

EXPLANATION OF PLATE XVI.

*Sardinia neopilchardus*, Steindachner.

Figure 1.—Larva 7·5 mm. in length. Dorsal fin just beginning to appear.

Figure 2.—Larva 11·5 mm. in length. Note copepod in alimentary canal.

Figure 3.—Larva 15·5 mm. in length.

Figure 4.—Larva 28 mm. in length. Dorsal fin with 19 rays. Pelvic fins well developed.