Review

STATUS OF THE IDENTIFICATION OF LARVAE OF BIVALVE MOLLUSCS IN INDONESIA

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ABSTRACT

Proper identification of larvae of bivalve molluscs is important for biodiversity studies, and for the environmental studies in general. But, in Indonesia, the experience is limited. Studies on larval identification of bivalve species are very rare. Morphological characters of tropical bivalve larvae seem comparable to those of related species of temperate waters, though not always. Hence it is imperative to have work on the identification of tropical bivalve larvae initiated.

INTRODUCTION

Meroplankton samples from Ancol waters, Jakarta Bay contained 15 % molluscan larvae, 3 % of which were larvae of green mussel Perna viridis. (Sutomo & Romimohtarto 1988). Gastropod larvae dominated followed by bivalve larvae. In estuarine areas such as Jobokuto, Jepara, Central Java, meroplankton samples can contain 60 % molluscan larvae, and half of these would be bivalve larvae. Roberts *et al.* (1982) listed 111 species in 29 families of bivalve species from Jakarta Bay. Matsukuma (1984) recorded 112 species of 26 families from Eastern Caroline and Marshall Island, Western Pacific. These regions were potentially rich in bivalve species, typically from coral reef and mangrove ecosystems. Ockelmann (1994) distinguished 8 species of oyster larvae in plankton samples from the Andaman Sea, Thailand.

Studies on the identification of bivalve larvae build on a long tradition developed in the temperate region. Rees (1950) described and classified larvae of 77 species from North Atlantic plankton samples. Rees's (1950) work was based on characters of the shell: shape, texture, and hinge structure (soft parts were not included). He was uncertain of some species identified by the 'indirect' approach and suggested confirmation through larval rearing of known parents in the laboratory. Loosanoff & Davis (1963) developed a more comprehensive description of larval shells based on culture of larvae. Through careful measurement of developing larvae from egg to late umbonal stage, Loosanoff *et al.* (1966) found that the length-height relationship of larvae of 20 species of bivalve mollusc were constant. Besides Rees's terminology, Loosanoff *et al.* (1966) put emphasis on length-height relationship of prodissoconch shell throughout larval development and umbonal shapes. Chanley & Andrews (1971) described and compiled larvae of 23 bivalve species occurring in Virginia (about half of the species in the region). They also emphasised the shell measurements and considered not to include hinge structure in the terminology because of the difficulties of routine valve separation and observation.

Panggabean (1989, 1994) reared larvae of *Crassostrea gigas* and *Mytilus edulis* from the temperate region, and *Perna viridis* (Panggabean 1996) from Indonesian waters. The early development to straight-hinge larvae of *Perna viridis* was two times faster than its relative *Mytilus edulis*. Culture of tropical species may be advantageous since spawning of most of the species occurs all year round (Kastoro 1975, 1978) and larval development is fast. In comparison, the temperate species have a short spawning season and longer larval development.

Terminology used in studies of temperate bivalves is adopted for the identification of larvae of bivalve species of this region. A country project on larvae of bivalve species has been proposed with the objective to provide descriptions of laboratory-reared bivalve larvae. The suggested terminology is described in this paper.

REVIEW OF METHODS AND TERMINOLOGY

Stages of larval development

Based on the literature available to us (Rees 1950; Loosanoff *et al.* 1966; Chanley & Andrews 1971) we suggest that Chanley & Andrew's terminology is appropriate for the determination of larvae of bivalve molluscs. Few larvae of tropical bivalves have been cultured and described: tridacnids (La Barbera 1975; Jameson 1976; Gwyther & Munro 1981; Fitt *et al.* 1984; Crawford *et al.* 1986; Dwiono 1994), pearl oyster (Minaur 1969) and green mussel (Tan 1976). For identification, we need to compare morphological characters of larval shells. After fertilisation and the rapid embryonic development to trochophore, the first stage of shelled larva is the straight-hinge larva (Fig. 1A). This stage develops into the veliconcha (Fig. 1B). The straight-hinge stage (prodissoconch I) is usually distinctly marked off from the veliconcha shell (prodissoconch II). Ockelmann (1995) put emphasis on a well defined third stage in certain Mytilacea. The stage, nepioconch, is a juvenile shell stage. Finally, the adult shell (dissoconch) is formed, usually clearly marked off from the larval shell (prodissoconch) (Fig. 1C).

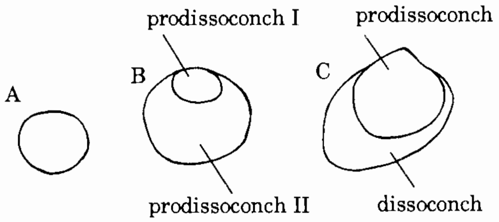


Figure 1. Stages of bivalve larva: A. veliger ("straight-hinge stage" or "D-shape larva"); B. veliconcha (umbo stage); C. juvenile (based on Rees 1950).

Dimensions

Dimensions to be measured are hinge line, total length and height (Fig. 2). Hinge line is the dorsal area of the shell where the two valves are permanently attached. Total length: the greatest shell distance parallel to the hinge line. Height (or width) is the greatest shell distance in the dorso-ventral plane perpendicular to the length. The hinge-line length is a prodissoconch-I measurement which is important because it does not increase appreciably during the larval development (Chanley & Andrews 1971). They observed that straight-hinge larvae persisted until having a hinge line at least half the total length. Umbo larvae began with a hinge line less than half the total length or with well developed umbos.

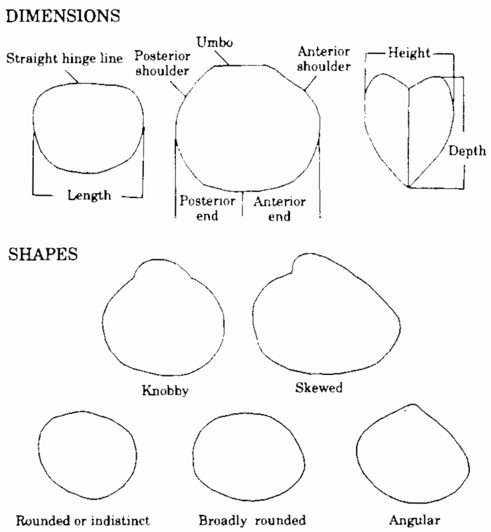


Figure 2. Dimensions of straight-hinge or umbo stage and umbonal shapes for the description of larvae of bivalve species (adapted from Loosanoff *et al.* 1966).

Shape

1) Five basic shapes of the umbo can be distinguished: round, broadly rounded, angular, knobbly and skewed (Fig. 2). Their outline may be continuous (round, broadly rounded, angular) or discontinuous (knobbly and skewed) with the shoulders.

2) The dorsal aspect of the shell between the hinge or umbo and respective ends of the shell may be straight or curved (shape of shoulder). The steepness and length of the slope are also important features.

3) The relative height of umbo and shoulders to total height may comprise from 1/3 to more than 1/2 of the total height (maximum dorsoventral dimension).

4) The velum extends from the anterior end of the larva. The anterior end is usually marked by a more gradual slope of the shell edge. The anus is located in the posterior end of the larva. The shape of anterior and posterior ends of valves may be blunt or pointed. The relative lengths of ends are measured from an imaginary perpendicular line drawn from the hinge to the ventral margin (Fig. 2). Valve ends may be nearly equal in length and shape, or one end may be either appreciably longer, or more pointed. The ventral margin or the valve may be round, flat or semicircular.

5) The hinge. Rees (1950) reported characteristics of hinge teeth and ligaments of 21 superfamilies of bivalve molluscs, but Chanley & Andrew (1971) suggested that, in general, it would be too difficult to observe the hinge in routine work.

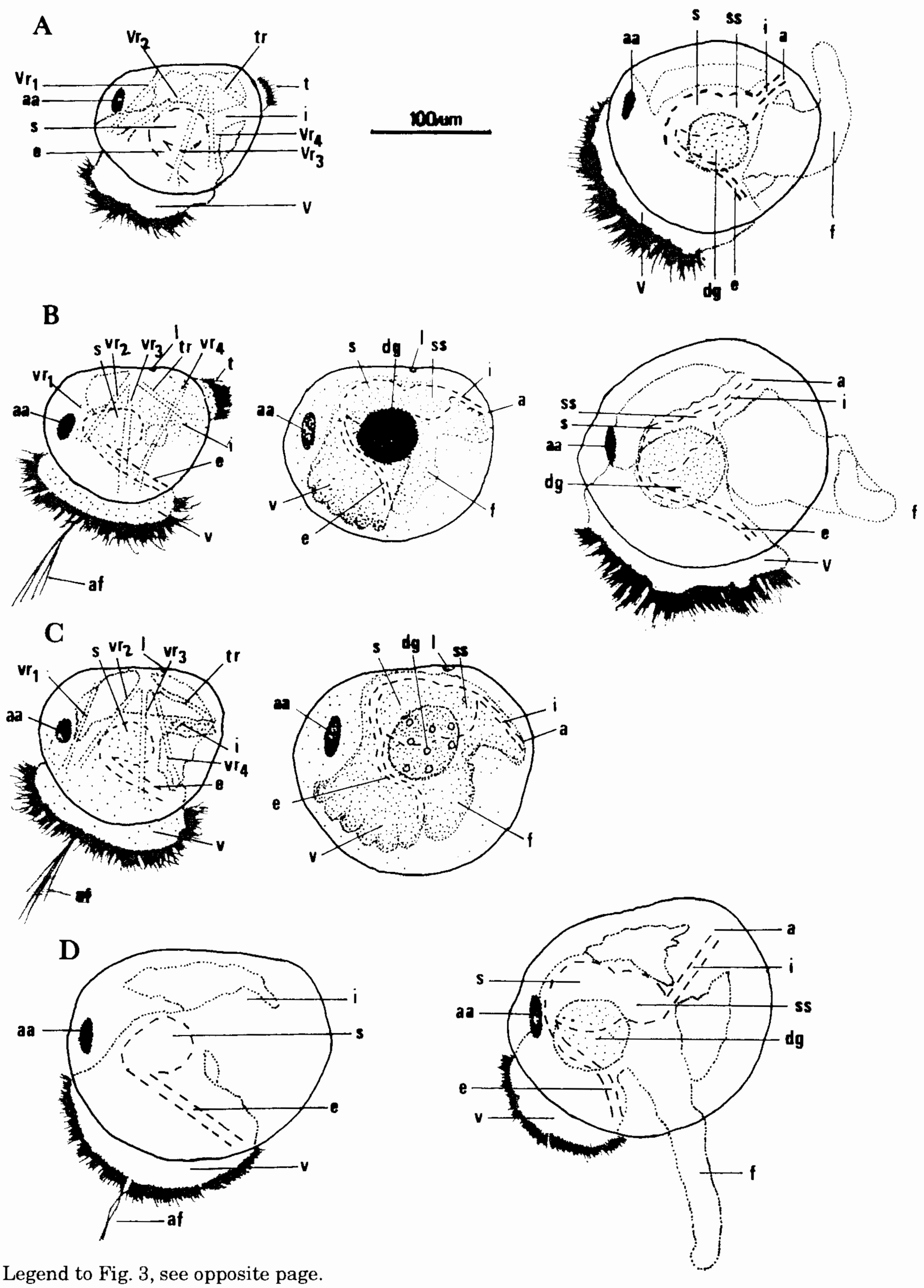
6) Special characters. Characteristics such as coloration, texture, thickness of valve edges, byssal notch, eyespot, and apical flagellum are useful in identification of larvae.

7) When shapes and dimensions are compared, the valves of larvae should be measured in the same position. They should lie on one side with both ends in the same plane.

STUDIES ON TRIDACNID LARVAE

Giant clams, Tridacnidae are common in the Indo-Pacific region (Morton 1979). Four reared species have been described; *Tridacna crocea*, *T. maxima*, *T. squamosa* and *Hippopus hippopus* (La Barbera 1975; Jameson 1976). The larvae were distinguished by the very large prodissoconch-I (length more than 128 µm), and relatively small metamorphosed larval stage (length about 200 µm). The shape was broadly round. According to Chanley & Andrews's (1971) definition, the larvae had no definite umbo stage. The larvae remain D-shaped, after two days, but their total length is more than twice the hinge-line length. The total length of this stage has exceeded the straight-hinge stage according to Chanley & Andrew's definition (op. cit.), and they should have become umbo larvae. The four tridacnid species are differentiated by their size, shoulders and velar retractor muscle (Fig. 3). Anterior adductor muscle, telotroch, velum with four apical flagellae, and velar retractor mussel are always present during the early stage of the tridacnid larvae. The telotroch disappears when the foot begins to form after day 3 (Fig. 3b). Shoulders of early larvae of *T. crocea* and *T. maxima* have less steep anterior slopes compared to the posterior shoulders. The shoulder of *T. squamosa* is opposite to *T. crocea* and *T. maxima*. The difference between *T. crocea* and *T. maxima* is the position of the insertion of the fourth velar retractor muscles on the shell (compare Prodissoconch-I of the three species, Fig. 3a). The hinge is formed before larvae metamorphose into benthic spat. The hinge of tridacnids is characterised by Rees (1950) as the cardiacean type (La Barbera 1975). The hinge is similar to the hinge of *Laevicardium mortoni*: the ligament is posterior in position; the right valve has lateral teeth; the anterior lateral tooth is 1/3 longer than the posterior lateral tooth; anterior and posterior teeth function as sockets for the teeth in the left valve.

Larvae of tridacnids resembles the lecithotrophic larvae, *Lyonsia hyalina* and *Gemma gemma*. Big size with no typical



Legend to Fig. 3, see opposite page.

straight-hinge or umbo stage, short larval life and relatively small at the stage of metamorphosis. Those three species are not related, however it is suggested that the similarity was due to the lecithotrophic relation (Chanley & Andrews 1971). The similarity of hinge type of *Laevicardium mortoni* (Cardiidae) and Tridacnidae shows the close relationship of the two families.

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⇐ Figure 3. Comparative diagram of day-2 veliger and pediveliger (various age) of *Tridacna crocea* (A); *T. maxima* (B); *T. squamosa* (C); and *Hippopus hippopus* (D). Anus (a); anterior adductor (aa); apical flagella (af); digestive gland (dg); esophagus (e); foot (f); intestine (i); ligament (l); stomach (s); style sac (ss); telotroch (t); velum (v); velar retractor (vr). Redrawn from various sources.

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ISSN 0858-3633