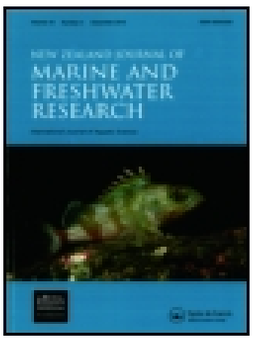

New Zealand Journal of Marine and Freshwater Research

ISSN: 0028-8330 (Print) 1175-8805 (Online) Journal homepage: http://www.tandfonline.com/loi/tnzm20

Common bivalve larvae from New Zealand: Pteriacea, Anomiacea, Ostreacea

J. D. Booth

To cite this article: J. D. Booth (1979) Common bivalve larvae from New Zealand: Pteriacea, Anomiacea, Ostreacea, New Zealand Journal of Marine and Freshwater Research, 13:1, 131-139, DOI: 10.1080/00288330.1979.9515786

To link to this article: http://dx.doi.org/10.1080/00288330.1979.9515786

Published online: 30 Mar 2010.

New Zealand Journal of Marine & Freshwater Research, 1979, 13(1): 131–139.

Common bivalve larvae from New Zealand: Pteriacea, Anomiacea, Ostreacea

J. D. BOOTH*

Marine Laboratory, Department of Zoology, Victoria University of Wellington, Wellington, New Zealand

Among the common late-stage bivalve larvae occurring in plankton samples from the Bay of Islands (35°15'S, 174°10'E), Wellington Harbour (41°16'S, 174°51'E), and Raumati Beach (40°56'S, 174°58'E), New Zealand, during 1970–72 were two species provisionally identified as *Atrina pectinata zelandica* (Gray) (Pteriacea: Pinnidae) and *Anomia trigonopsis* Hutton (Anomiacea: Anomiidae). The seasonal occurrences of these larvae in the plankton, as well as those of *Saccostrea glomerata* (Gould) and an as yet unnamed *Ostrea* sp. (Ostreacea: Ostreidae), are described.

INTRODUCTION

In this study two species of bivalve larvae—*Atrina pectinata zelandica* (Gray) and *Anomia trigonopsis* Hutton—are described and provisionally identified. Their seasonal occurrence in the plankton, and that of two other species described elsewhere—*Saccostrea glomerata* (Gould) and an as yet unnamed *Ostrea* species—is also given. The study forms part of a series describing and provisionally identifying common bivalve larvae recovered from plankton samples from the Bay of Islands, Wellington Harbour, and Raumati Beach during 1970–72 (Booth 1972); an earlier part (Booth 1977) covered the mytilid larvae. Again, late-stage veligers (veliconchae) and early pediveligers are mainly dealt with, these being the stages at which the species are most readily distinguishable.

Superfamily Pteriacea is represented in New Zealand by just one family and species, the horse mussel *Atrina pectinata zelandica.* This familiar bivalve is the largest occurring in New Zealand, reaches more than 30 cm in length, and is found throughout the country in sublittoral sandy and muddy substrates in mainly protected shore areas, but also in relatively clean, offshore, sandy grounds (Morton & Miller 1968).

The most abundant representative of family Anomiidae in New Zealand is *Anomia trigonopsis,* which occurs on stones and shells at low water and beyond, mainly in warmer northern areas.

Representatives of family Ostreidae include the familiar northern rock oyster, *Saccostrea glomerata,* occurring as stragglers at least as far south as Cook Strait, but most abundantly north of East Cape, and an as yet unnamed *Ostrea* species occurring in northern New Zealand harbours.

The development of the veliger larvae of *Atrina pectinata zelandica, Anomia trigonopsis,* and *Saccostrea glomerata* is of the pelagic type (see Chanley 1969), and has a long planktotrophic stage. The unnamed *Ostrea* sp., occurring at one of the three sampling localities (Bay of Islands), has hypolarviparous development (see Chanley 1969); the larva is incubated through about one-third of its development, and is pelagic after release (Dinamani 1971a).

No New Zealand pteriacean larvae have so far been described, and the larval features of this group have received little attention in the literature. Bernard (1898), Borisiak (1909), Rees (1950), Yoshida (1956), and Ota (1961) have recorded the distinctive triangular shape of various pinnid larvae. Rees (1950) reviewed descriptions of pteriacean hinges; most have a series of arcacean-like teeth (small, numerous, and approximately equal in size) and a posterior series of mytilacean-like teeth.

Similarly, no New Zealand anomiacean larvae have been described, although Jorgensen (1946), Rees (1950), Loosanoff *et al.* (1966), and Chanley & Andrews (1971) have reviewed the studies on larvae of this group from elsewhere. The main features of the group include the right valve being almost flat with a very poorly developed umbo compared to the left valve, the development of a byssal notch which usually becomes very distinct at or near metamorphosis, and a hinge structure similar to that of mytilacean larvae except that the region between the two thickened parts of the provinculum is so thin that the teeth are minute or absent.

New Zealand ostreacean larvae have received some attention in the literature; Rainer (1964) and Dina-

Received 12 January 1978; revision received 10 October 1978
*Present address: *Fisheries Research Division, Ministry of Agriculture and Fisheries, P.O. Box 19062, Wellington, New Zealand*
Fisheries Research Division Publication 343

mani (1973, 1976) have described the larva of *Saccostrea glomerata* (=*Crassostrea glomerata*), and both authors (also Dinamani 1974) have included details of the seasonal occurrence of the species in the plankton. (Dinamani (1971a) figured the early-stage larvae of the hypolarviparous *Ostrea* sp. just before release from the adults; a full description of the larva of this species is at present in preparation (P. Dinamani, pers. comm.).)

SAMPLING AREAS AND METHODS

Details of the sampling areas and times, methods, and the limitations of the sampling design have been given by Booth (1974, 1975, 1977). Briefly, three plankton stations were occupied in the Bay of Islands (35°15′S, 174°10′E) (April 1970–December 1971), four in Wellington Harbour (41°16′S, 174°51′E) (May 1970–February 1972), and four at Raumati Beach (40°56′S, 174°58′E) (June 1971–June 1972); the locations of these stations are given in Booth (1977, fig. 1 & 2). Details of the hydrology of the Bay of Islands and Wellington Harbour during the sampling period are given in Booth (1974, 1975). Sampling was carried out at approximately monthly intervals, mainly with a free-fall net of 120 μm mesh based on a design by Smith *et al.* (1968). Descriptions of larvae use the terminology of Chanley & Andrews (1971) for most features and that of Rees (1950) for hinge characters. The larval dimensions give the size of the late-stage larvae most often observed in the plankton samples. Hinge line length is the length of the provinculum. 'Late-stage larvae' refers to both the late veliger and pediveliger stages; other details relating to the larval descriptions are given in Booth (1977).

DESCRIPTIONS AND SEASONAL OCCURRENCE OF LARVAE

The seasonal occurrences of each larva that was found in substantial numbers in the Bay of Islands and Wellington Harbour are presented on a modified log scale (see Fig. 2, 4, 6, & 8). A single species (Pinnid 1) occurred at Raumati Beach, and its abundance is indicated in the text.

PINNID 1 (? *Atrina pectinata zelandica* (Gray) (Fig. 1 & 2, Tables 1 & 2)

DIMENSIONS. Larvae 250–400 μm in length; average length to height to hinge line length 1:1.10:0.28 at 250–299 μm, 1:1.04:0.26 at 300–349 μm, and 1:1.02:0.23 at 350–399 μm. Settling size apparently highly variable – larvae up to 800 μm in length are encountered in the plankton.

SHAPE (Fig. 1). Early umbo stages distinctive in shape, higher than most other larvae of similar length; the broadly rounded to knobby umbos become prominent early in development; throughout development, right umbo higher than left umbo. In late-stage larva, umbos still more knobby, anterior end more pointed and longer than posterior end, and both shoulders slope steeply from umbos, giving a marked triangular shape. Ventral margin broadly rounded, and overall shape of larva rather flat.

HINGE (Fig. 1). In late-stage larvae 350 μm in length, hinge consists of thickened provinculum with anterior region of 5–8 small, even teeth, an undifferentiated central region, and a posterior region of 2–4

Table 1. Relative abundance of adults of pinnid and anomiid species at Bay of Islands, Wellington Harbour, and Raumati Beach, 1970–72. Other species in the same family not included in the lists for each locality were either much less common or absent. Sources of data: Booth (1972); Beu & Climo (1971); reports from local shell collectors; and reports from Victoria University Diving Club and Wellington Shell Club. (c, common; f, frequent.)

	Family	Species	Abundance	Distribution
Bay of Islands	Pinnidae	*Atrina pectinata zelandica*	f	Subtidal substrates
	Anomiidae	*Anomia trigonopsis*	c	Subtidal rock
Wellington Harbour	Pinnidae	*Atrina pectinata zelandica*	f	Subtidal substrates
Raumati Beach	Pinnidae	*Atrina pectinata zelandica*	f	Subtidal substrates

Table 2. Summary of main occurrences of late-stage bivalve larvae at Bay of Islands, Wellington Harbour, and Raumati Beach, 1970–72 (c, common, i.e., >10 but <100 larvae per 1000 litres of seawater; f, frequent, i.e., >1 but <10; o, occasional, i.e., <1; —, not found).

Species	Bay of Islands	Wellington Harbour	Raumati Beach
Pinnid 1	Jan–Feb (o) Apr–Oct (o)	Jan–Feb (f) Mar (o) May–Jul (o, f, c)	Jan (o)
Anomiid 1	Dec–Mar or Apr (f, c)	—	—
Saccostrea glomerata	Dec–Mar or Apr (o, f)	—	—
Ostrea sp.	Nov or Dec–Apr (f, c)	—	—

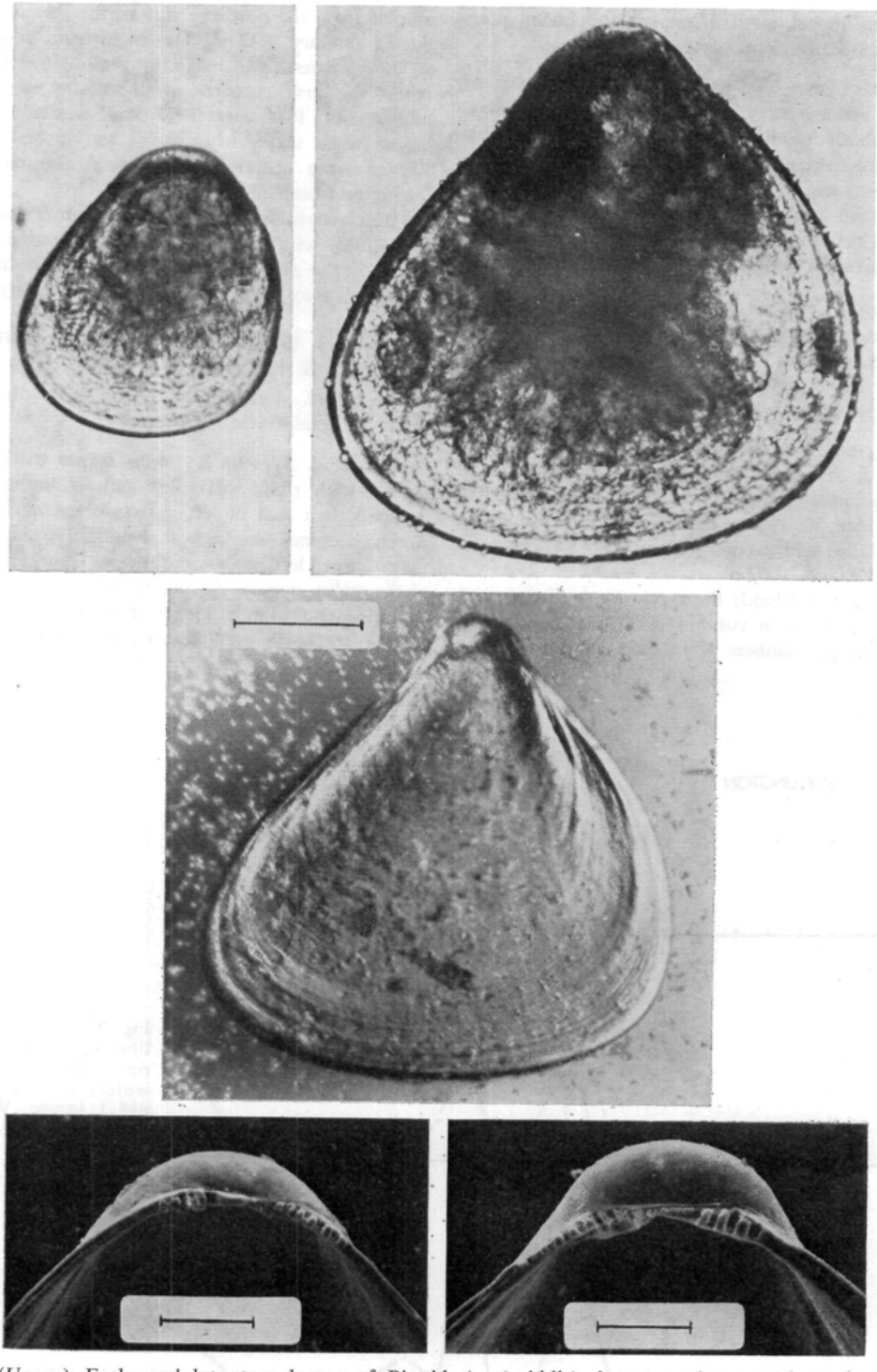

Fig. 1. (*Upper*) Early and late-stage larvae of Pinnid 1; (*middle*) late-stage larva with surface texture accentuated using Nomarski differential interference contrast; scale line, 100 μm. Hinge of left valve (*lower left*) and right valve (*lower right*) of late-stage larva (lengths 350 μm and 480 μm respectively) of Pinnid 1; scale line, 40 μm.

large, often uneven teeth. Ligament attachment point lies near anterior region of teeth.

OTHER FEATURES. The triangular shape and size of this larva make it very distinctive. Concentric lamellae over both prodissoconch shells clearly visible under Nomarski differential interference contrast (DIC) microscopy (Fig. 1, middle), but the two prodissoconch shells not usually clearly delineated. Late-stage larva becomes darker grey with increasiing size. No eyespot evident during development.

COMPARISON WITH OTHER SPECIES. In all its developmental stages this larva is very similar in shape and other features to *Atrina pectinata japonica,* described by Yoshida (1956) and Ota (1961), and *Pinna atrina japonica,* described by Ota (1961).

DISTRIBUTION AND SEASONAL ABUNDANCE (Fig. 2, Tables 1 & 2). This larva, as well as the adults of *Atrina pectinata zelandica,* occurred at all sampling localities, but it was taken too infrequently at the Bay of Islands and Raumati Beach to record graphically.

At the Bay of Islands the larva occurred occasionally at all stations in autumn 1970 and during most of 1971. Large numbers were recorded in plankton samples from the northern side of the Bay of Islands during January 1972 (P. Dinamani, pers. comm.).

The greatest densities in Wellington Harbour, where the larva occurred at all stations, were during midsummer 1971 and 1972 and winter 1971. No larvae were taken from April to November 1970. Larvae were occasionally taken at Raumati Beach during midsummer 1971.

The observations suggest peak summer and winter spawnings, with occasional trickle spawning at other times of the year. Apparently, spawnings in successive years may vary considerably in intensity.

ANOMID 1 (*? Anomia trigonopsis* Hutton) (Fig. 3 & 4, Tables 1 & 2)

DIMENSIONS. Larvae 220–250 μm in length; average length to height ratio 1:1.04.

SHAPE (Fig. 3). Early umbo stages distinctive in shape, with right valve flat and its umbo less developed than that of left valve. Anteroventral byssal notch becomes marked at length 230 μm. In late-stage larva, left umbo knobby and very prominent, right umbo poorly developed and right valve flat. Anterior end slightly longer than posterior end, and appears more pointed because of byssal notch. The

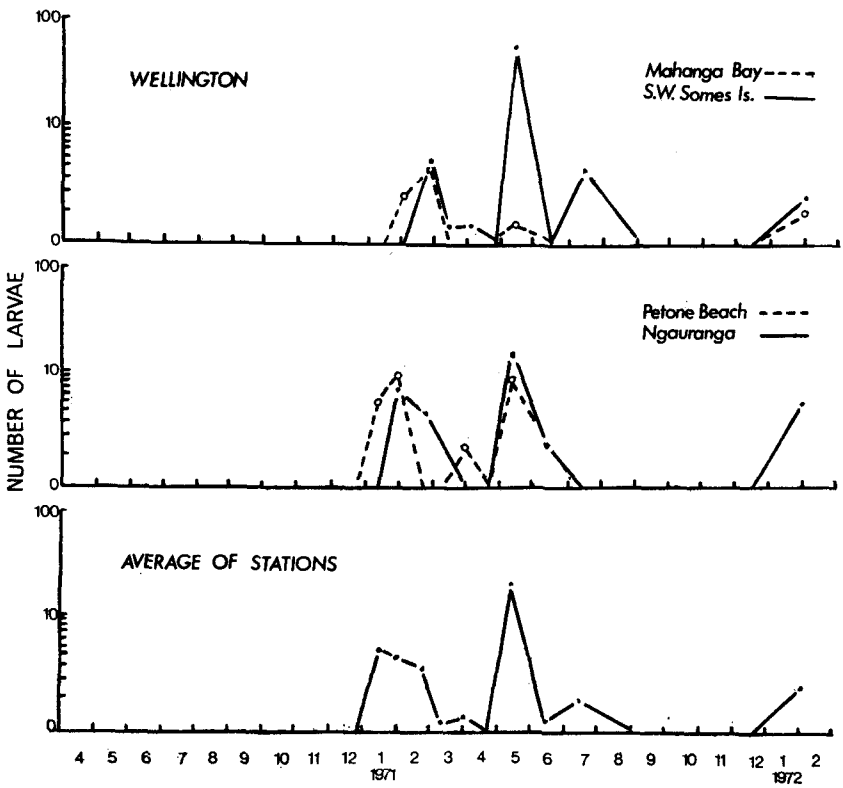

Fig. 2. Monthly variation in abundance (nos per 1000 litres of seawater) of late-stage Pinnid 1 larvae, Wellington Harbour, May 1970–Feb 1972.

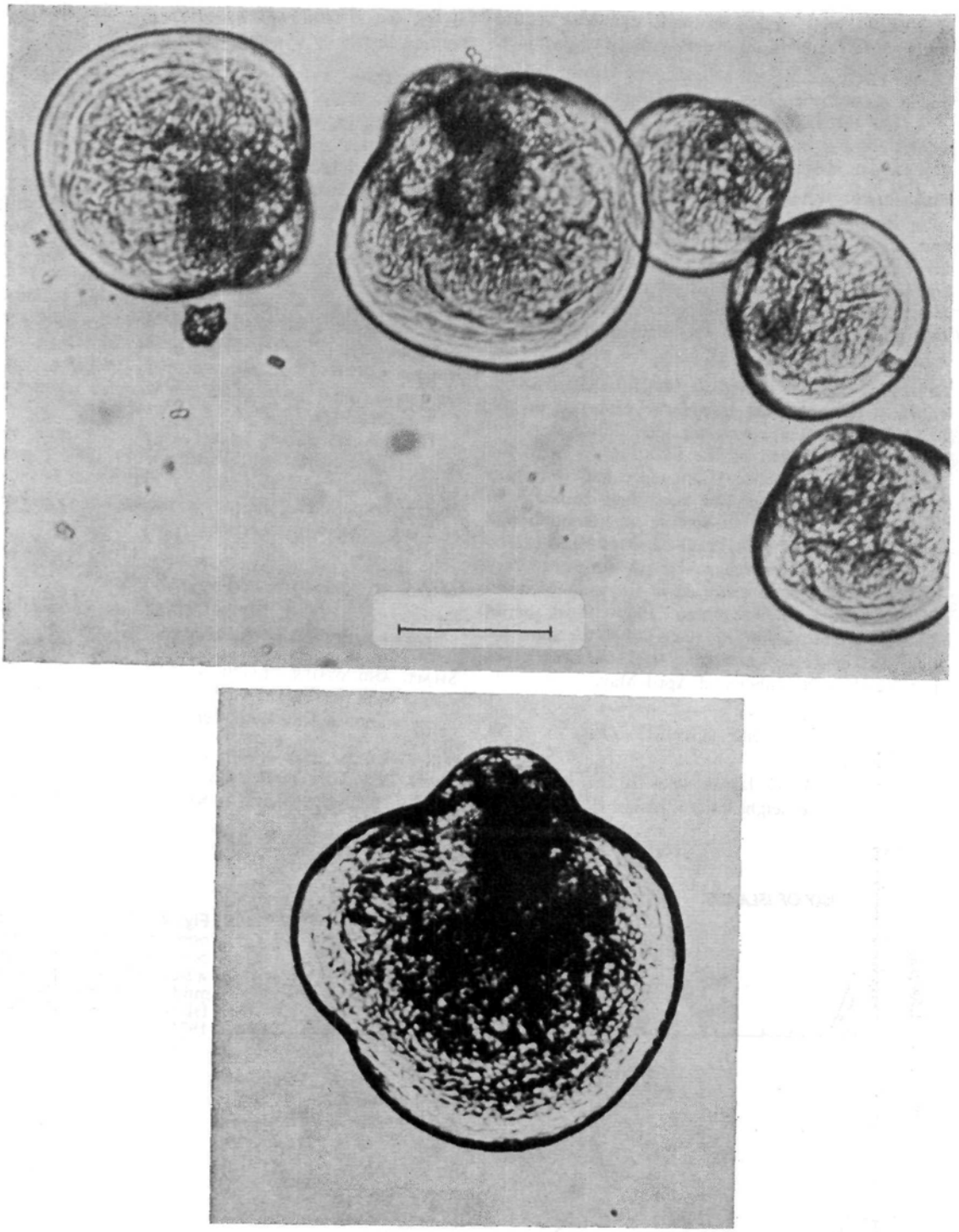

Fig. 3. Early and late-stage larvae of Anomiid 1; scale line, 100 μm.

moderately high shoulders and rounded ventral margin give the larva an overall circular appearance.

OTHER FEATURES. Shell colourless or faintly yellow, fragile. Concentric lamellae visible under Nomarski DIC, but the two prodissoconch shells not clearly delineated. Eyespot occasionally observed in larvae over 240 μm in length.

COMPARISON WITH OTHER SPECIES. In all its developmental stages this larva is very similar in shape and dimensions to *Anomia lischkei*, described by Miyazaki (1935). It also closely resembles in shape and other features anomiids described by several other authors, including Bernard (1896), Jorgensen (1946), Sullivan (1948), Rees (1950), and Chanley & Andrews (1971).

DISTRIBUTION AND SEASONAL ABUNDANCE (Fig. 4, Tables 1 & 2). This larva was observed at the Bay of Islands only, as were the adults of *A. trigonopsis*. It occurred at the two stations with the most estuarine influence (Confluence and Brampton Reef) during summer. The larva first appeared in December, when the sea-surface temperature was about 21°c (Booth 1974), and persisted until March or April. Peak occurrence was in early February 1971; no larvae were observed in the samples taken on 3 December 1971. Skerman (1959) noted similar although more prolonged times of settlement for *A. walteri* (=*A. trigonopsis*) at Auckland, with peaks in November–December and April–May.

Saccostrea glomerata (Gould) (Fig. 5 & 6, Table 2)

DIMENSIONS. Eyed larvae 260–330 μm in length; average length to height ratio 1:1.12.

SHAPE AND OTHER FEATURES (Fig. 5). See descriptions of larvae by Dinamani (1973, 1976).

DISTRIBUTION AND SEASONAL ABUNDANCE (Fig. 6, Table 2). This larva was observed only at the Bay of Islands, the main area of the three for the adults of this species. It occurred during summer, mainly at Confluence and Waewaetoria stations, with a first appearance in December, when the sea-surface temperature was about 21°c, and persisting until March or April (21–22°c). These observations are generally consistent with the records of Rainer (1964), Greenway (1969), and Dinamani (1974), who inferred or observed similar spawning periods. Peak occurrence of larvae was in early February 1971, as was also observed in the Bay of Islands by Dinamani (1974), sampling over a similar period. No larvae were observed in the samples taken on 3 December 1971.

Although *Crassostrea gigas* has recently been reported from Northland (Dinamani 1971b), it was either absent or else very scarce in the Bay of Islands during the period of the present study, for no larvae of this species were observed.

Ostrea sp. (Fig. 7 & 8, Table 2)

DIMENSIONS. Eyed larvae 240–320 μm in height; average length to height ratio 1:1.1.

SHAPE AND OTHER FEATURES (Fig. 7). A full description of larvae of this species is at present in preparation (P. Dinamani, pers. comm.).

DISTRIBUTION AND SEASONAL ABUNDANCE (Fig. 8, Table 2). This larva was observed only at the Bay of Islands, where it occurred at all stations,

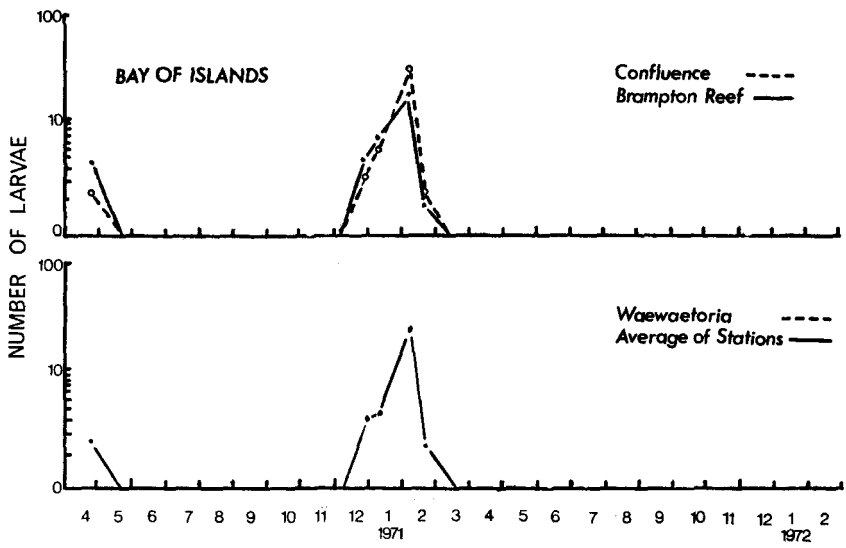

Fig. 4. Monthly variation in abundance (nos per 1000 litres of seawater) of late-stage Anomiid 1 larvae, Bay of Islands, Apr 1970–Dec 1971.

mainly during summer. First appearance was in late November, when sea-surface temperatures reached 19°c, and the larva persisted in the plankton until the end of April, when temperatures were again 19°c. Peak occurrence of larvae was in late February 1971; occasionally larvae were also taken during winter and spring 1971. The inferred spawning and swarming times are generally consistent with those given by Dinamani (1971a).

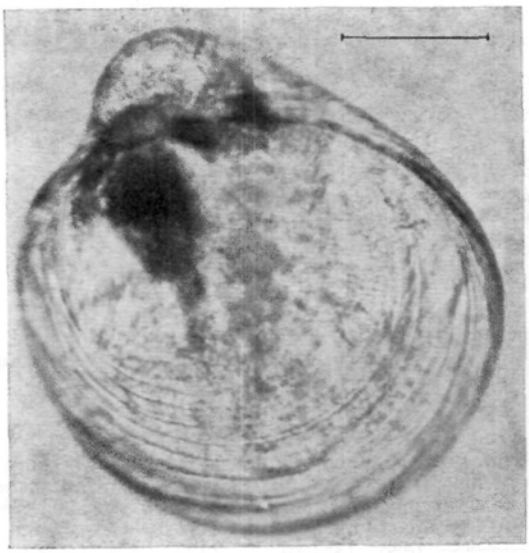

Fig. 5. Late-stage larva of *Saccostrea glomerata;* scale line, 100 μm.

DISCUSSION

The two larvae described in this study have been allocated to their respective family groupings and provisionally identified to species level on the following bases.

1. For both, the external morphology of the larva closely resembles published descriptions of species of the same or allied genera of the same family elsewhere in the world.
2. In Pinnid 1 (provisionally identified as *Atrina pectinata zelandica*) the hinge structure is basically consistent with that described for Pteriacea by Rees

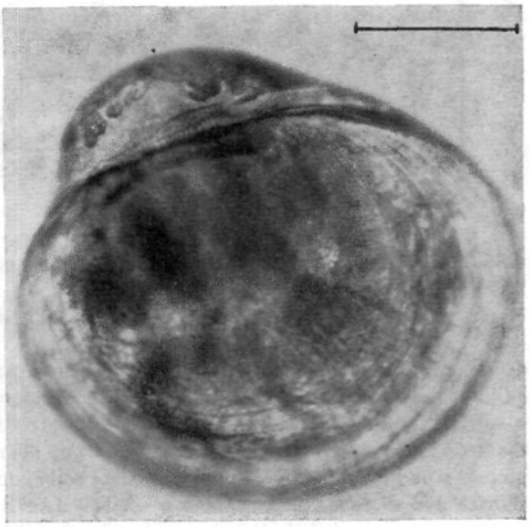

Fig. 7. Late-stage larva of *Ostrea* sp.; scale line, 100 μm.

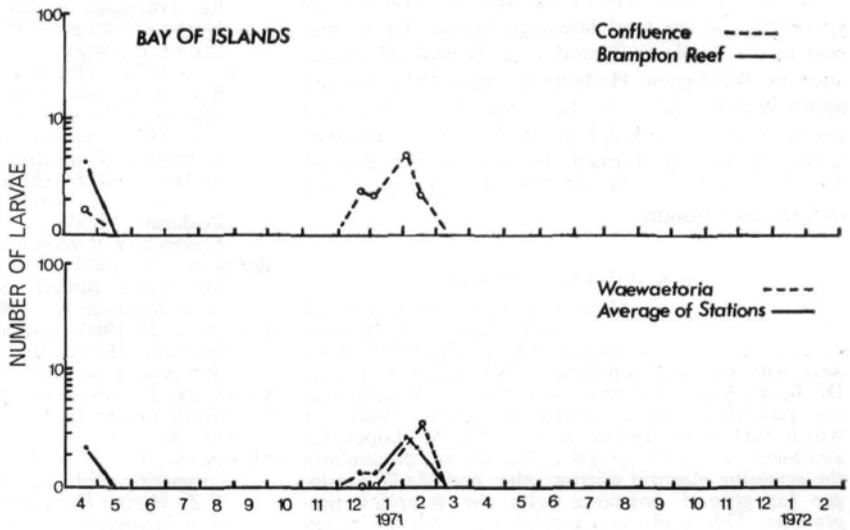

Fig. 6. Monthly variation in abundance (nos per 1000 litres of seawater) of late-stage larvae of *Saccostrea glomerata,* Bay of Islands, Apr 1970–Dec 1971.

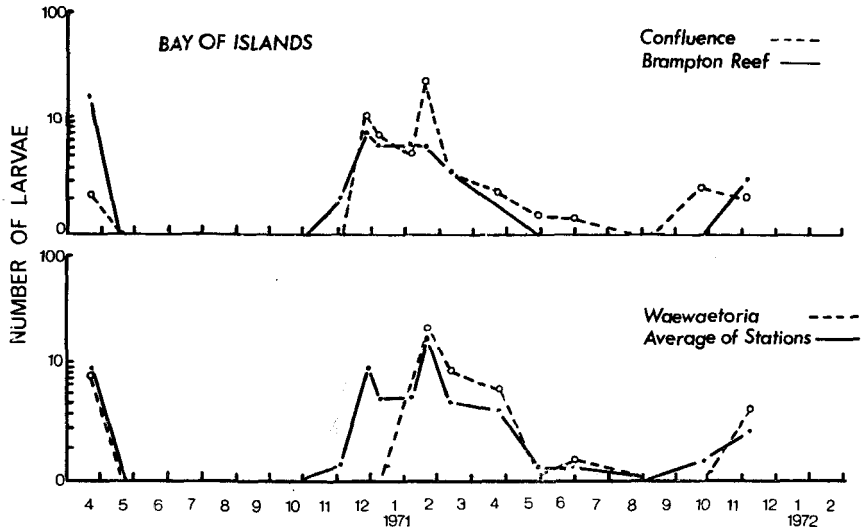

Fig. 8. Monthly variation in abundance (nos per 1000 litres of seawater) of late-stage larvae of *Ostrea* sp., Bay of Islands, Apr 1970–Dec 1971.

(1950). The hinge structure of Anomiid 1 was not investigated.

3. In both larvae, the distribution is consistent with that of the corresponding adult.

Conclusive identification of both species can be made only by spawning and rearing them in the laboratory.

Although the frequency of sampling allows only the broadest patterns of larval occurrence to be determined, it is apparent that the four species had much shorter and more defined spawning seasons than the five mytilids recorded during the study (Booth 1977), with midsummer the main period in common. The seasonal occurrences of *Anomia trigonopsis*, *Saccostrea glomerata*, and *Ostrea* sp. are generally consistent with previous results from the same or nearby areas.

At no time did any of the species form a high percentage of the total late-stage bivalve larvae present in the plankton. Pinnid 1, at its peak of abundance in Wellington Harbour in May 1971, formed approximately 20% of the total of 29 late-stage bivalve larvae recorded, but less than 5% at all other times; *Ostrea* sp. formed 15–18% in the Bay of Islands in February–March 1971, but less than 5% during other months.

ACKNOWLEDGMENTS

I thank my brother, Mr Robin Booth, for the use of his launch in the Bay of Islands; Messrs W. B. MacQueen and L. G. Robinson (r.v. *Tirohia*) for assistance with plankton sampling in Wellington Harbour; Dr R. B. Pike (Victoria University of Wellington) for general guidance during my Ph.D. study, of which this work formed a part; Mr M. Loper for assistance with photographing the larvae, particularly the scanning electron micrographs; and Mr G. Grainger for general assistance with the sampling programme. This study was carried out with the assistance of a U.G.C. Postgraduate Scholarship and a Fisheries Research Division Research Fellowship, both of which are gratefully acknowledged.

REFERENCES

BERNARD, F. 1896: Sur le développement et la morphologie de la coquille chez les Lamellibranches (Anisomyaires). *Bulletin de la Société Géologique de France 24*: 412–49.

———— 1898: Recherches ontogéniques et morphologiques sur la coquille des Lamellibranches. 1. Taxodontes et Anisomyaires. *Annales des Sciences Naturelles (Zoologie)*, Series 8: 1–208.

BEU, A. G.; CLIMO, F. M. 1971: Marine Mollusca of Wellington Harbour and approaches. *Wellington Shell Club Bulletin 29.*

BOOTH, J. D. 1972: "Studies on New Zealand bivalve larvae, with observations on the adults and on the hydrology of Bay of Islands and Wellington Harbour". Unpubl. Ph.D. thesis, Victoria University of Wellington.

———— 1974: Observations on the hydrology of Bay of Islands, New Zealand. *N.Z. Journal of Marine & Freshwater Research 8*: 671-89.

———— 1975: Seasonal and tidal variations in the hydrology of Wellington Harbour. *N.Z. Journal of Marine & Freshwater Research 9*: 333–54.

———— 1977: Common bivalve larvae from New Zealand: Mytilacea. *N.Z. Journal of Marine & Freshwater Research 11*: 407–40.

BORISIAK, A. 1909: Pelecypoda du plankton de la Mer Noire. *Bulletin Scientifique de la France et de la Belgique 42*: 149–81.

CHANLEY, P. 1969: Larval development in the class Bivalvia. *Marine Biological Association of India, Symposium on Mollusca 1968*: 475–81.

CHANLEY, P.; ANDREWS, J. D. 1971: Aids for identification of bivalve larvae of Virginia. *Malacologia 11*: 45–119.

DINAMANI, P. 1971a: Identification of oyster species competing with rock oysters for settlement space. *N.Z. Marine Department Fisheries Research Division Information Leaflet 1.*

——— 1971b: Occurrence of the Japanese oyster, *Crassostrea gigas* (Thunberg), in Northland, New Zealand. *N.Z. Journal of Marine & Freshwater Research* 5: 352–7.

——— 1973: Embryonic and larval development in the New Zealand rock oyster, *Crassostrea glomerata* (Gould, 1850). *The Veliger 15*: 295–9.

——— 1974: Reproductive cycle and gonadial changes in the New Zealand rock oyster *Crassostrea glomerata. N.Z. Journal of Marine & Freshwater Research 8*: 39–65.

——— 1976: The morphology of the larval shell of *Saccostrea glomerata* (Gould, 1850) and a comparative study of the larval shell in the genus *Crassostrea* Sacco, 1897 (Ostreidae). *Journal of Molluscan Studies 42*: 95–107.

GREENWAY, J. P. C. 1969: The monitoring of rock oyster (*Crassostrea glomerata*) settlement at Mahurangi, Auckland 1968–69. *N.Z. Marine Department Fisheries Technical Report 48.*

JORGENSEN, C. B. 1946: Lamellibranchia. Pp. 277–311 in THORSON, G. (Ed.), "Reproduction and larval development of Danish marine bottom invertebrates, with special reference to the planktonic larvae in the Sound (Oresund)". *Meddelelser fra Kommissionen for Danmarks Fiskeri-og Havundersogelser 4.*

LOOSANOFF, V. L.; DAVIS, H. C.; CHANLEY, P. E. 1966: Dimensions and shapes of larvae of some marine bivalve mollusks. *Malacologia 4*: 351–435.

MIYAZAKI, I. 1935: On the development of some marine bivalves, with special reference to the shelled larvae. *Journal of the Imperial Fisheries Institute 31*: 1–10.

MORTON, J.; MILLER, M. 1968: *The New Zealand Sea Shore.* Collins, London & Auckland.

OTA, S. 1961: Identification of the larva of *Pinna atrina japonica* (Reeve). *Bulletin of the Japanese Society of Scientific Fisheries 27*: 107–12.

RAINER, S. F. 1964: "The ecology of the Auckland rock oyster, *Crassostrea glomerata*". Unpubl. M.Sc. thesis, University of Auckland.

REES, C. B. 1950: The identification and classification of Lamellibranch larvae. *Hull Bulletins of Marine Ecology 3*: 73–104.

SKERMAN, T. M. 1959: Marine fouling at the Port of Auckland. *N.Z. Journal of Science 2*: 57–94.

SMITH, P. E.; COUNTS, R. C.; CLUTTER, R. I. 1968: Changes in filtering efficiency of plankton nets due to clogging under tow. *Journal du Conseil Permanent International pour l'Exploration de la Mer 32*: 232–48.

SULLIVAN, C. M. 1948: Bivalve larvae of Malpeque Bay, P.E.I. *Fisheries Research Board of Canada Bulletin 77.*

YOSHIDA, H. 1956: Early life-history of useful bivalves in the Ariake Sea (1). *Journal of the Shimonoseki College of Fisheries* 6: 115–22.