The Stratigraphic Distribution of the Molluscan Fossil Species in the Cycles of the Middle Part of the Omma Formation, Central Honshu, Japan

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The Stratigraphic Distribution of the Molluscan Fossil Species in the Cycles of the Middle Part of the Omma Formation, Central Honshu, Japan

Akihisa KITAMURA

Department of Earth Sciences, Faculty of Science, Kanazawa University *

Abstract : The stratigraphic distribution and relative frequency of all the identified molluscan species found in the ten cycles of the middle part of the Omma Formation at its type section are documented in order to supplement the information given in the previous paper (KITAMURA & KONDO, 1990). In all the cycles, the pattern of the stratigraphic succession as observed from all the identified species is consistent with that presented based on selected species.

1. Introduction

The type locality of the Omma Formation is known as one of the representative occurrences of the Omma-Manganji Fauna. This fauna named by OTUKA (1936, 1939a, b) appears from the Pliocene to lower Pleistocene formations, and is distributed mainly in the coastal area of the Japan Sea. Many works have dealt with the molluscan fauna of the Omma Formation for many years (*e.g.* KASENO & MATSUURA, 1965; OGASAWARA, 1977; MATSUURA, 1985) and concluded that the molluscan fossils are represented by the cold and shallow marine inhabitants ranging from low tide mark to 50-60m in water depth.

Recently, KITAMURA & KONDO (1990) analyzed the temporal changes in lithofacies and molluscan fossil associations, based on detailed field observation at the type section of the Omma Formation (Fig. 1). As a result, it is clarified that glacio-eustatic sea-level changes are detected in the shallow marine sedimentary sequence of the middle part of the formation, which are evidenced with at least ten cyclic changes of sedimentary facies and of autochthonous fossil molluscan associations.

Due to limited space, only the stratigraphic distribution and relative frequency of selected molluscan species were reported for each cycle in that paper. Therefore, I decided to document those of all the identified species collected by me with respect to each cycle here in 11 figures (Figs. 3-13). They are expected to be useful to understand relationship between the temporal change of geographic distribution of the faunal composition of the Omma-Manganji Fauna and environment change by glacio-eustasy during the early Pleistocene.

2. Sampling of the molluscan fossils

Previous studies (KASENO & MATSUURA, 1965; OGASAWARA, 1977; MATSUURA, 1985)

* Present address: Department of Geology & Mineralogy, Faculty of Science, Kyoto University

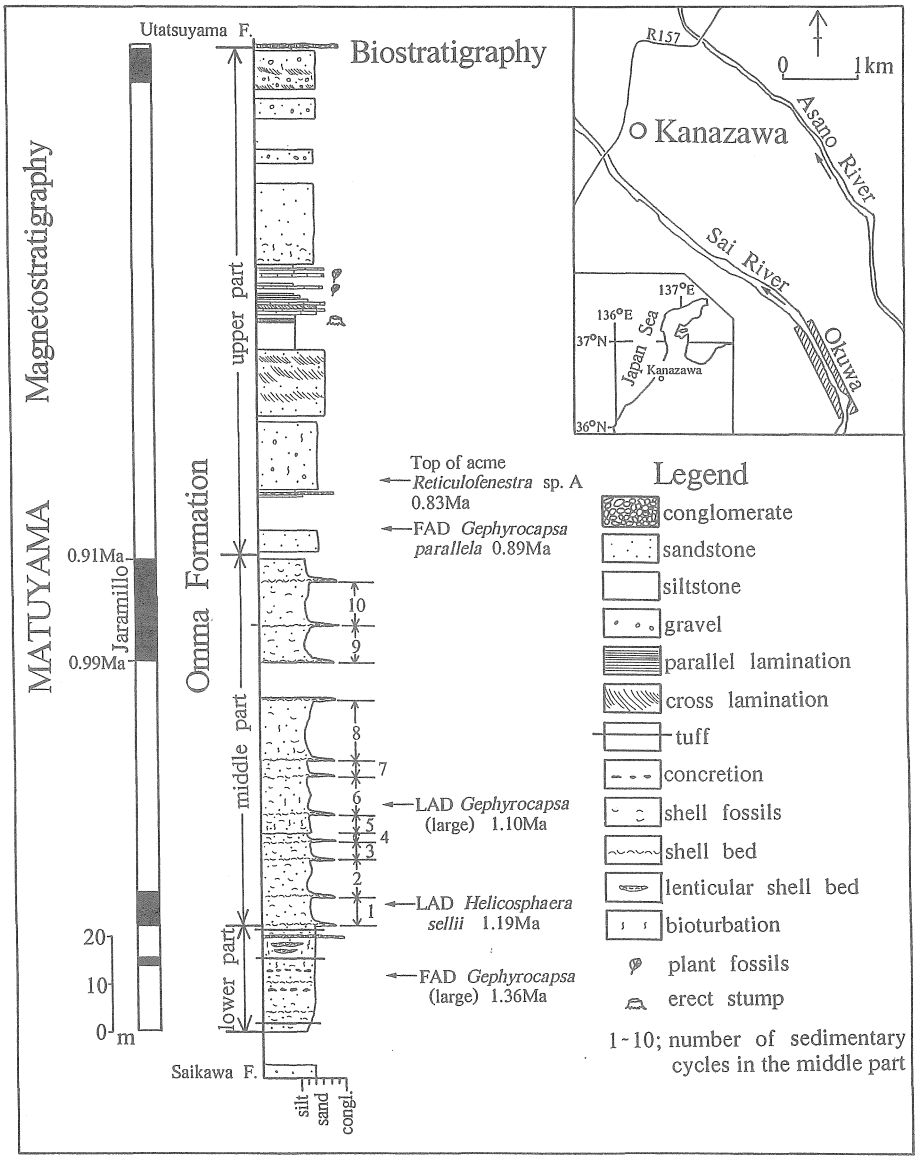

Fig. 1. Columnar section of the Omma Formation at the type locality. Biostratigraphy is after TAKAYAMA *et al.* (1988). Magnetostratigraphy is modified from OHMURA *et al.* (1989).

had paid attention mainly to the molluscan fossils in shell beds, but not to those sporadically scattered in sediment between shell beds. Thus, I made detailed analysis of the molluscan fossils with particular emphasis on those in the inter-shell-bed sediment.

The stratigraphic distribution of molluscan fossils in the middle part of the Omma Formation was determined by the following two methods.

For a shell bed, whole molluscan individuals embedded in the bedding surface "layer" of 2m wide and 5-30cm thick of each bed were identified and counted, and their mode of occurrence was observed. In the inter-shell-bed horizon yielding molluscan fossils sporadically, whole individuals were identified and counted and their mode of occurrence was examined in a rectangular block 1m long parallel to the strike and 0.5m wide. The surface of the exposures is so undulatory uneven, that thickness of the block had to range from 5 to 50cm. When only a few individuals of molluscan fossils occur in a block, supplementary fossils were sampled from the sediment next to the block.

3. General remarks

Lithofacies

A representative cycle consists of three-fold conformable lithologic units: they are, in ascending order, a basal shell bed, well-sorted fine-grained sandstone and muddy fine- to very fine-grained sandstone.

Basal shell bed: Except for the Cycle 5, each cycle starts with the shell bed which has an erosional base. Thickness of the shell bed ranges between 5 and 30cm. In the bed, shells are aligned in contact with each other.

Well-sorted fine-grained sandstone: This facies about 1m thick occurs in the lower part of each cycle, expect two cases (Cycles 1 and 10), and in the upper part of the Cycles 1, 8 and 9. The sandstone is fine-grained (2.5 to 3.0ϕ in mean grain size) and well-sorted (sorting-coefficient is about 0.7) with the mud content of 5 to 10%.

Muddy fine- to very fine-grained sandstone: The facies occupies the middle and upper parts of each cycle. The thickness of this facies ranges from 0.5 (Cycle 4) to 8m (Cycle 8). The mean grain size of the sandstone is 2.7 to 3.5ϕ with the mud content ranging from 15 to 45%.

Molluscan species and Associations

Cold- and warm-water and intermediate species: Based on the geographical distribution along the Pacific coast shelf area (KURODA & HABE, 1952: HIGO, 1973), the term "cold-water species" is here referred to species living in area north of 35° N and "warm-water species" for those in area south of 35° N. The species dwelling in both areas are grouped as the "intermediate species".

Associations: The fossil molluscan fauna of the middle part can be divided into eleven associations by means of the associated occurrence and relative abundance of the species (KITAMURA & KONDO, 1990). The term "association" is here used to indicate a suite of assemblages which are similar in species composition. Most of the molluscan species found in the formation are those now living in the sea around Japan, so that the associations can be compared with the living analogues. The environmental characters of the associations as to the nature of the sea water (cold, warm and transitional water), and approximate water depth of habitat were inferred from available information of the living species

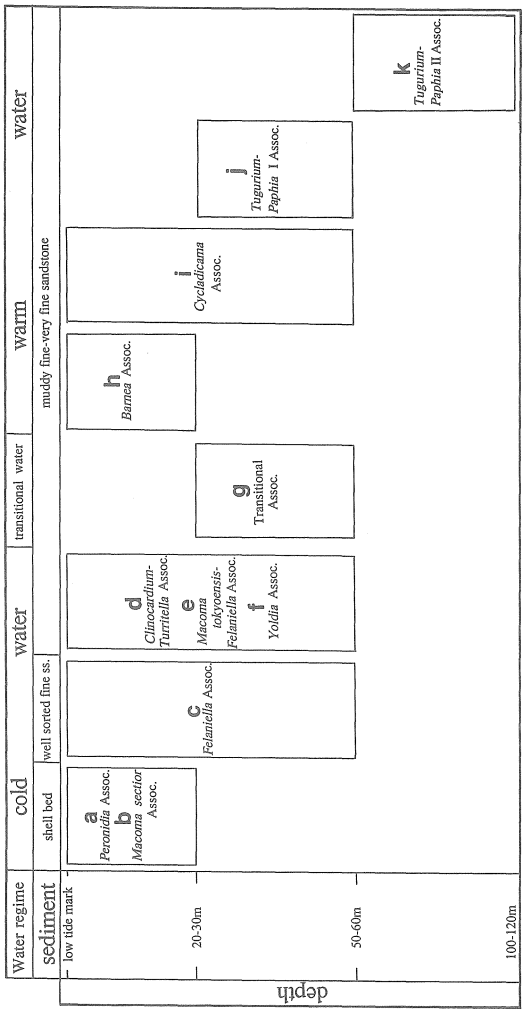

Fig. 2. Relationship between the molluscan fossil associations and environmental conditions in terms of water depth and water regime (after KITAMURA & KONDO, 1990).

(KURODA & HABE, 1952: HIGO, 1973: OYAMA, 1952, 1973) (Fig. 2).

The stratigraphic distribution and relative frequency of all the identified species in each cycle and the bed above Cycle 10 are illustrated in Figs. 3-13.

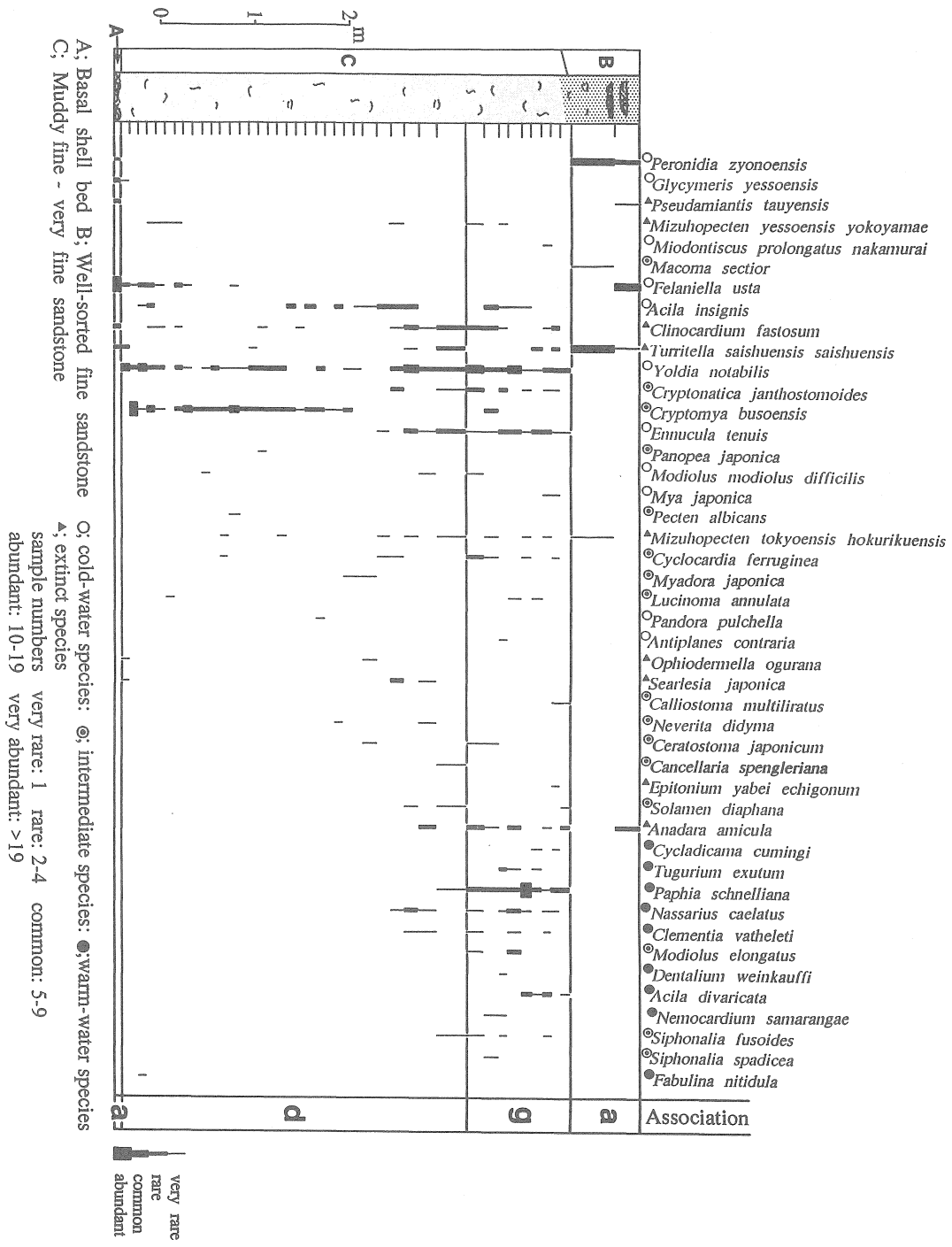

Fig. 3. Stratigraphic distribution and relative frequency of all molluscan species and molluscan fossil associations in the Cycle 1. See legend in Figs. 1 and 2.

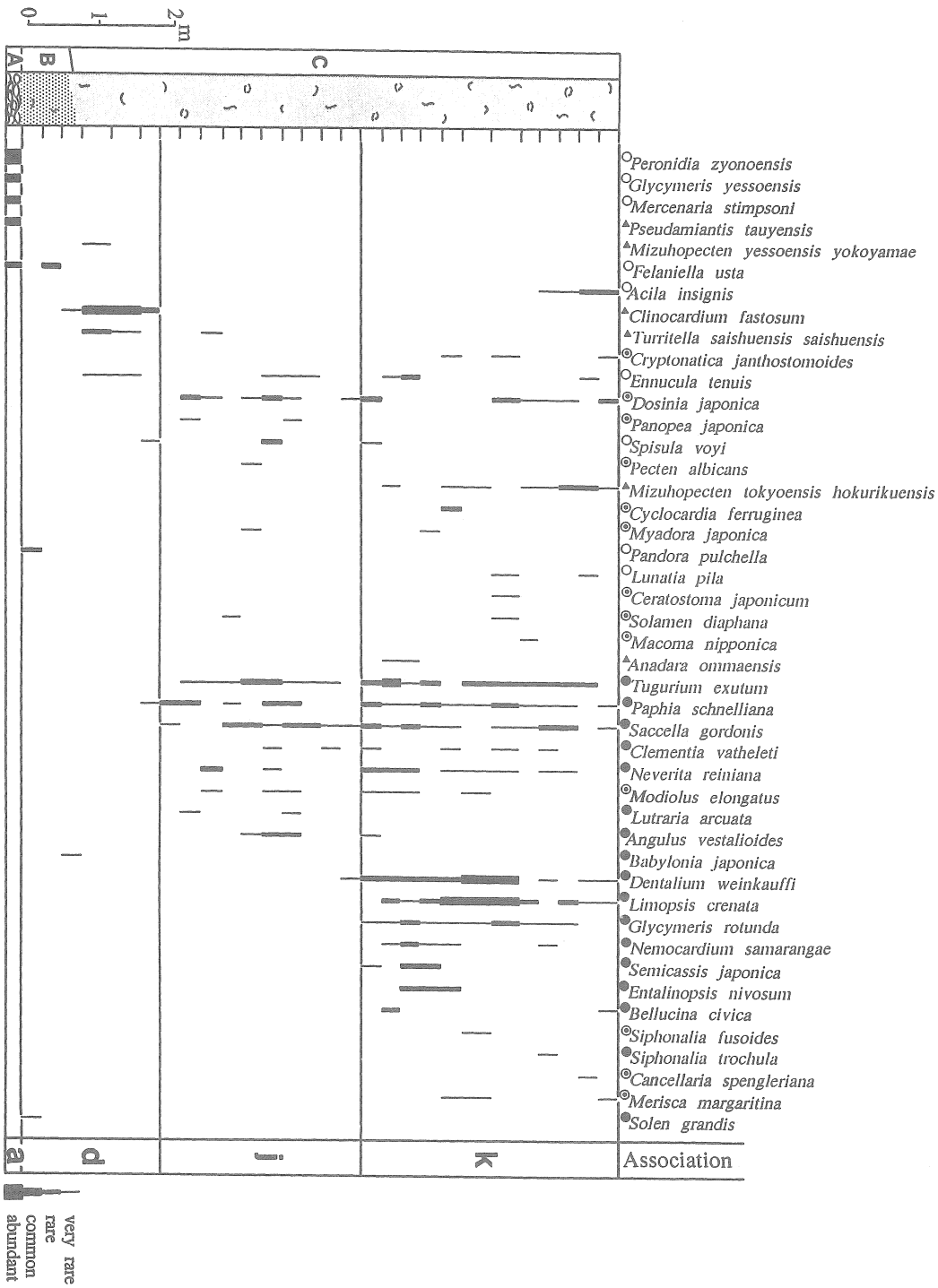

Fig. 4. Stratigraphic distribution and relative frequency of all molluscan species and molluscan fossil associations in the Cycle 2. See legend in Figs. 1, 2 and 3.

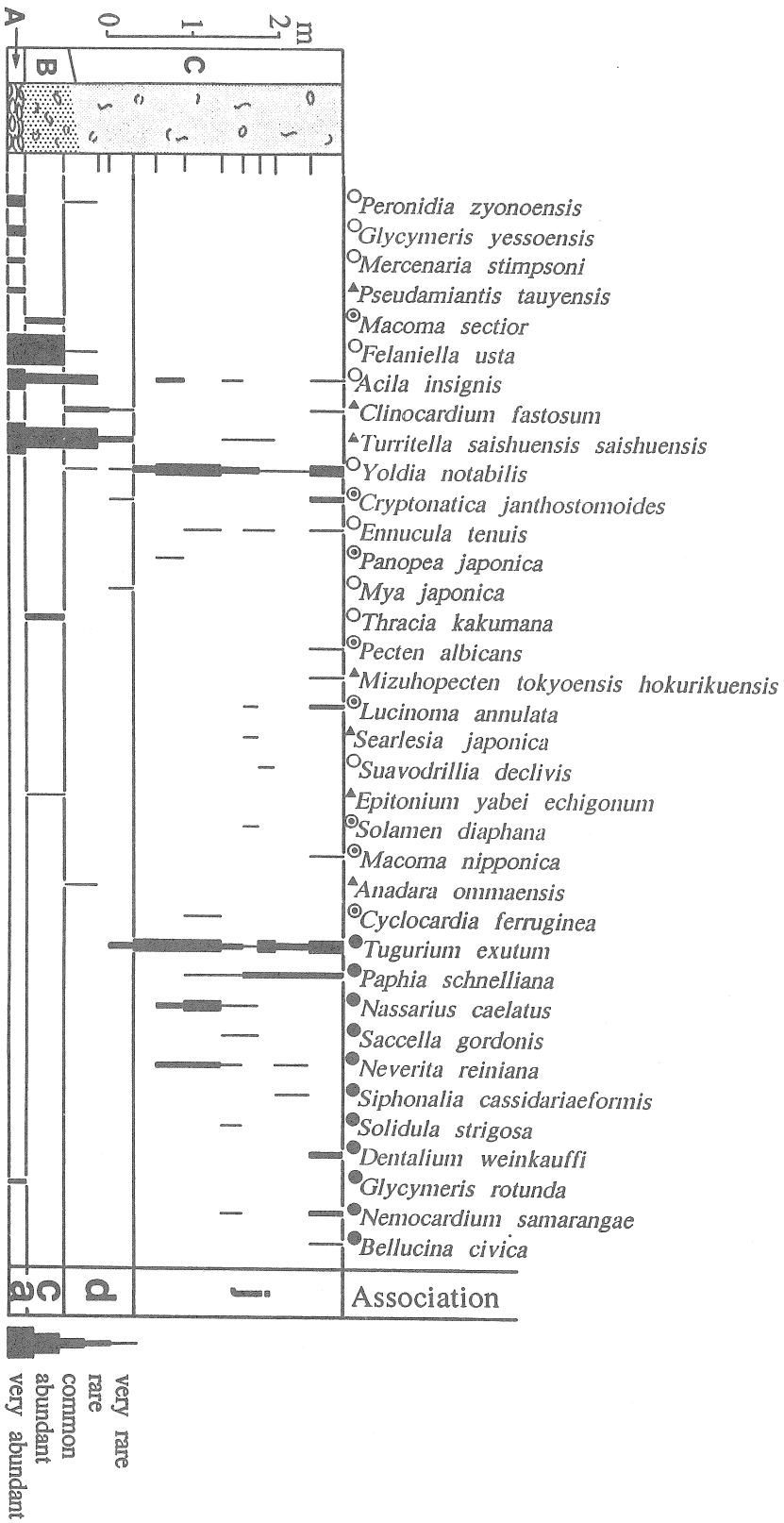

Fig. 5. Stratigraphic distribution and relative frequency of all molluscan species and molluscan fossil associations in the Cycle 3. See legend in Figs. 1, 2 and 3.

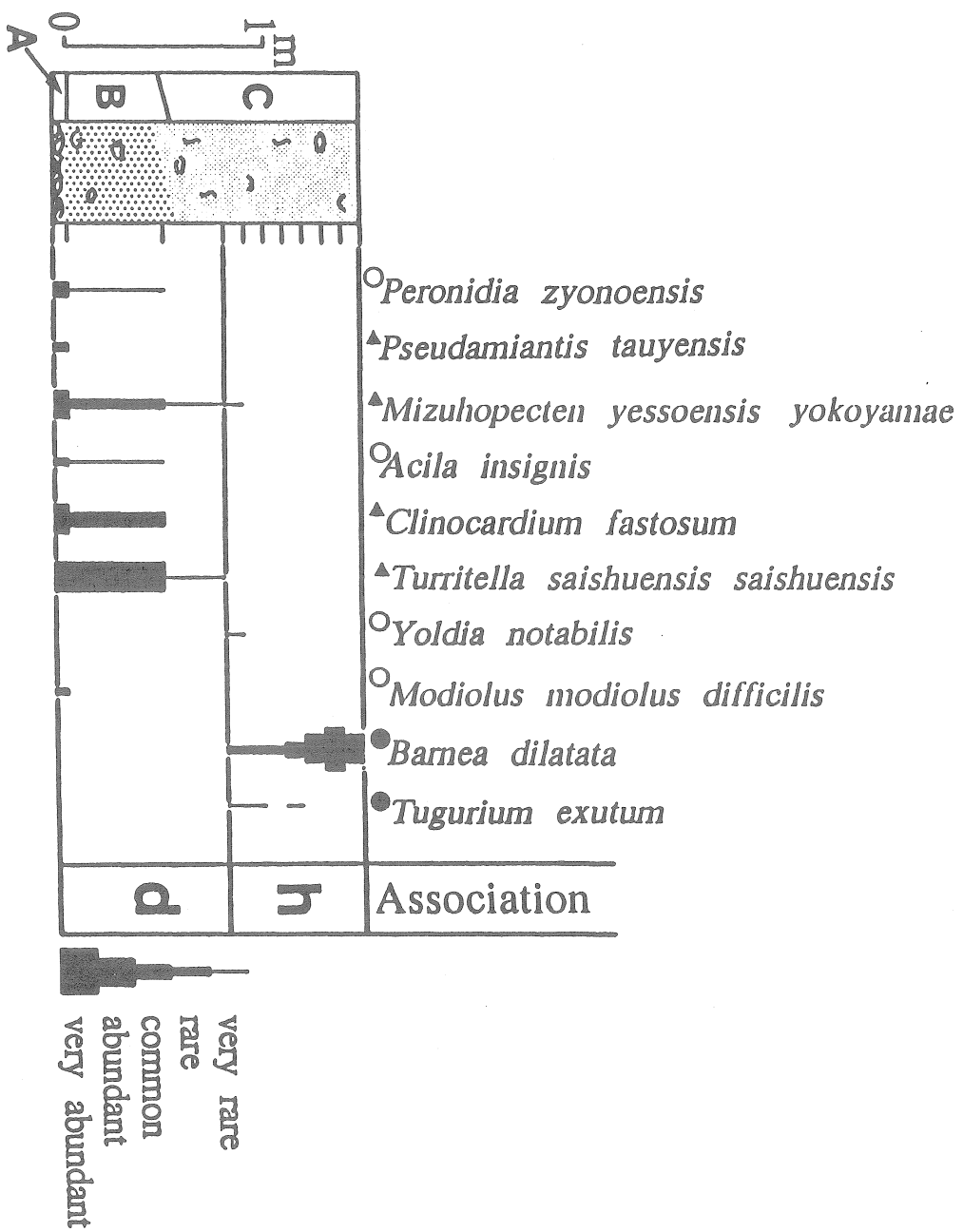

Fig. 6. Stratigraphic distribution and relative frequency of all molluscan species and molluscan fossil associations in the Cycle 4. See legend in Figs. 1, 2 and 3.

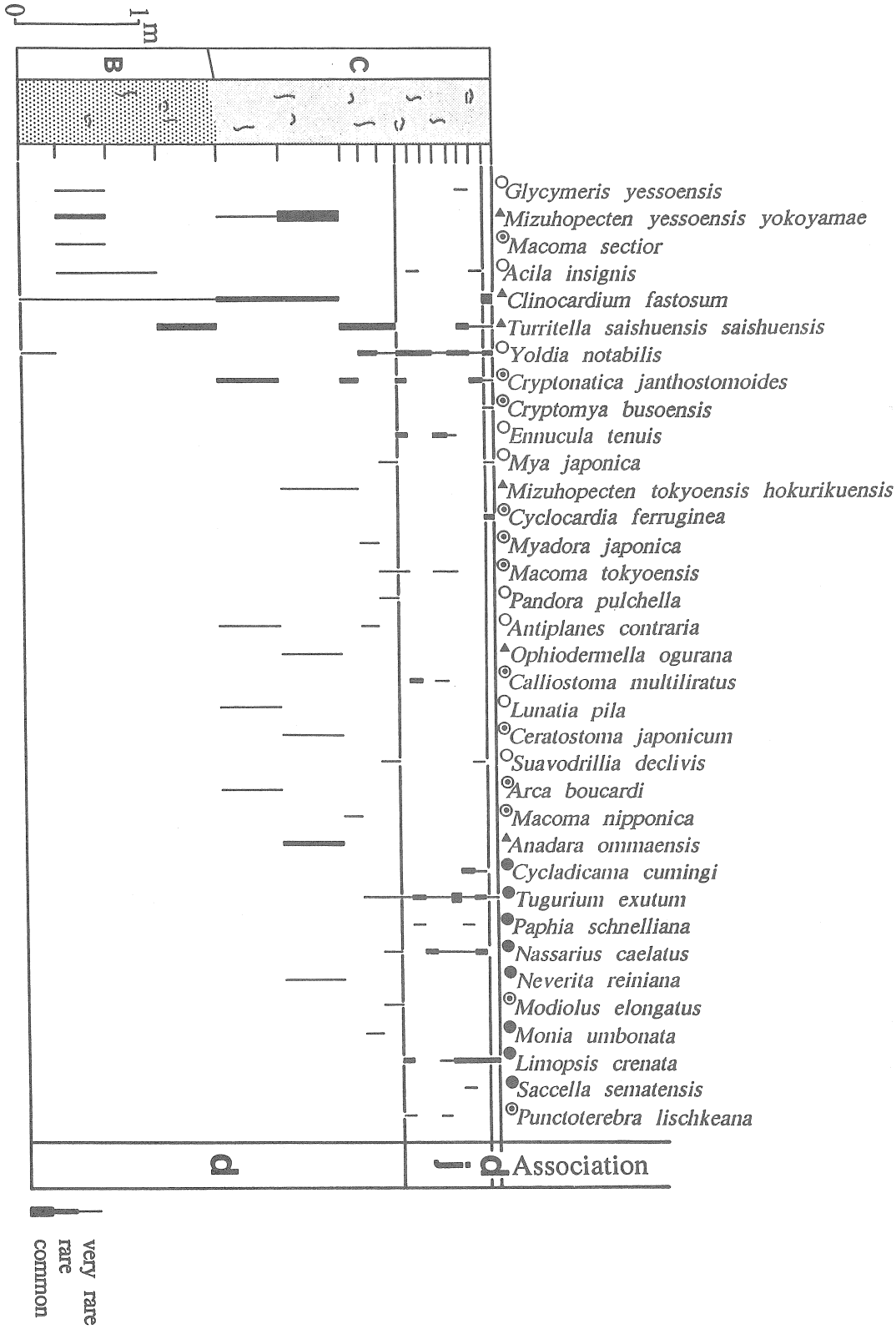

Fig. 7. Stratigraphic distribution and relative frequency of all molluscan species and molluscan fossil associations in the Cycle 5. See legend in Figs. 1, 2 and 3.

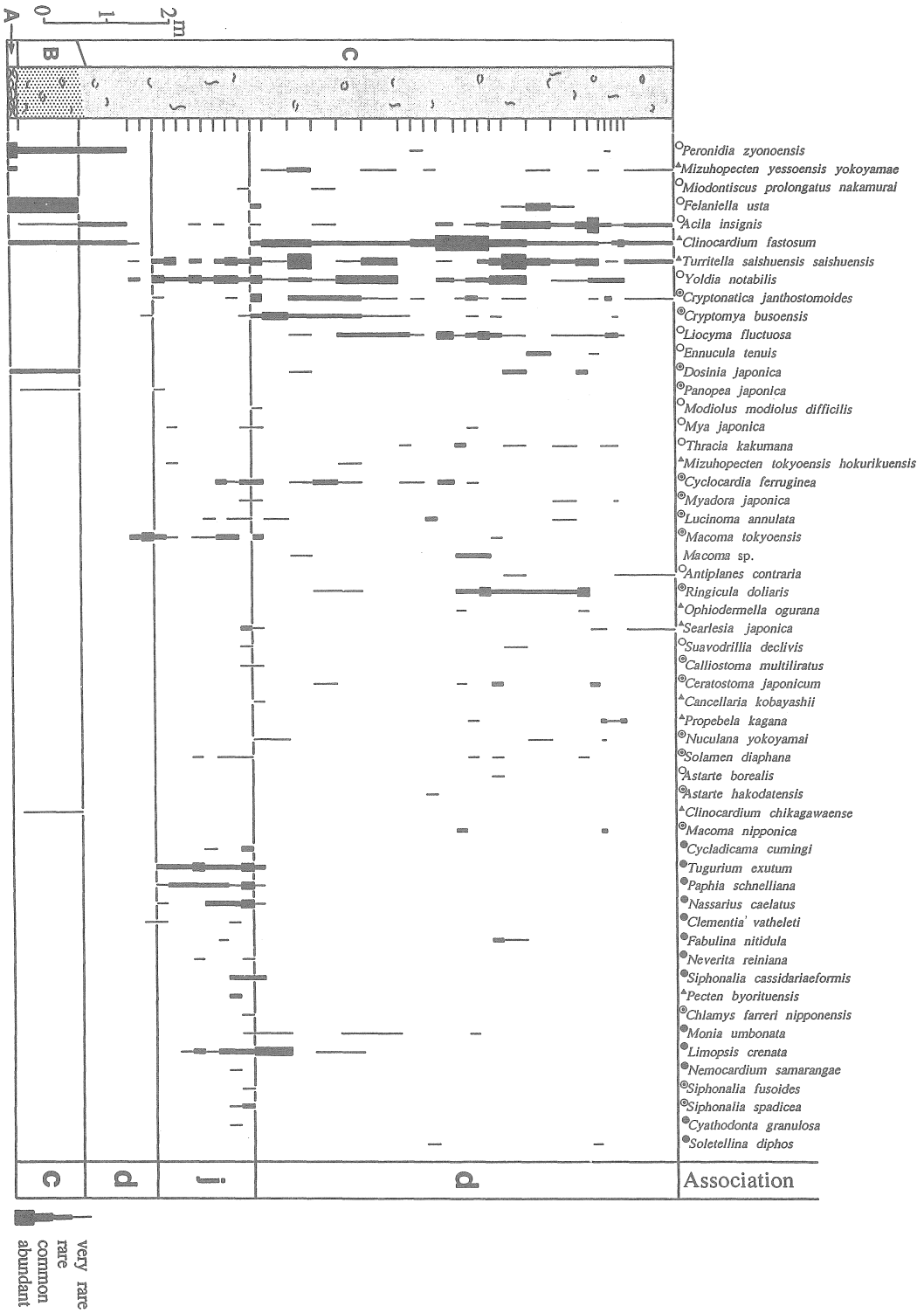

Fig. 8. Stratigraphic distribution and relative frequency of all molluscan species and molluscan fossil associations in the Cycle 6. See legend in Figs. 1, 2 and 3.

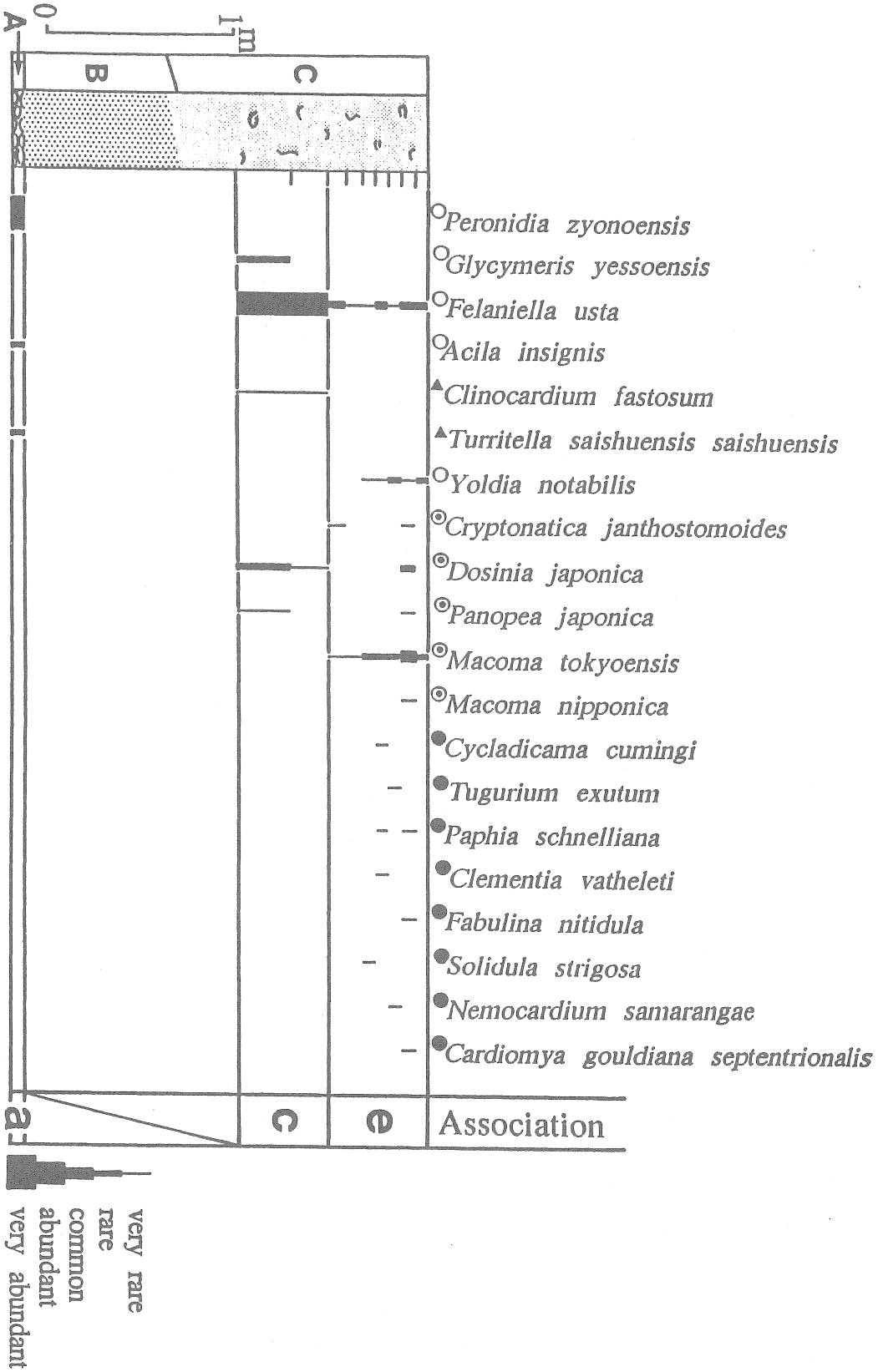

Fig. 9. Stratigraphic distribution and relative frequency of all molluscan species and molluscan fossil associations in the Cycle 7. See legend in Figs. 1, 2 and 3.

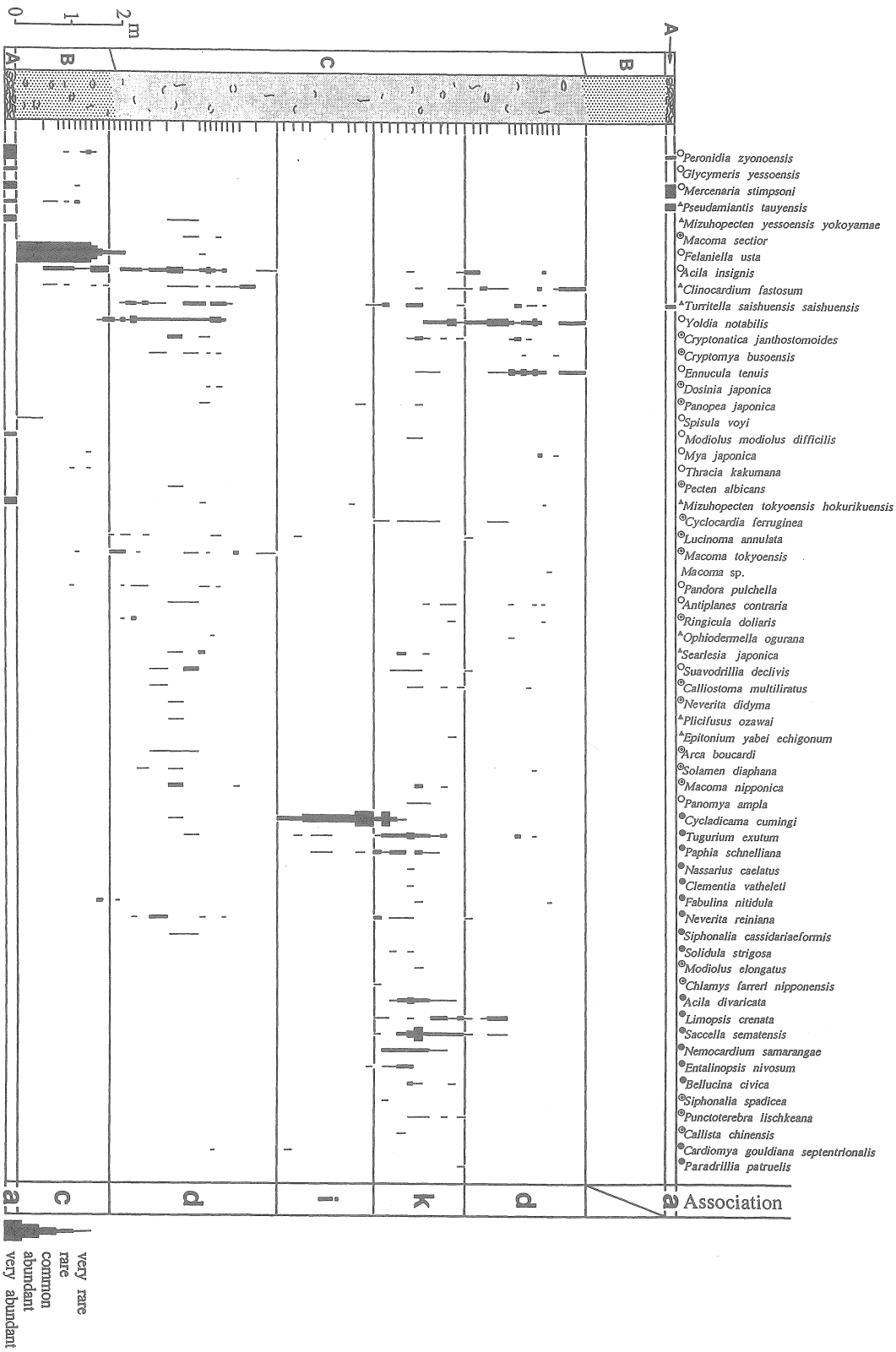

Fig. 10. Stratigraphic distribution and relative frequency of all molluscan species and molluscan fossil associations in the Cycle 8. See legend in Figs. 1, 2 and 3.

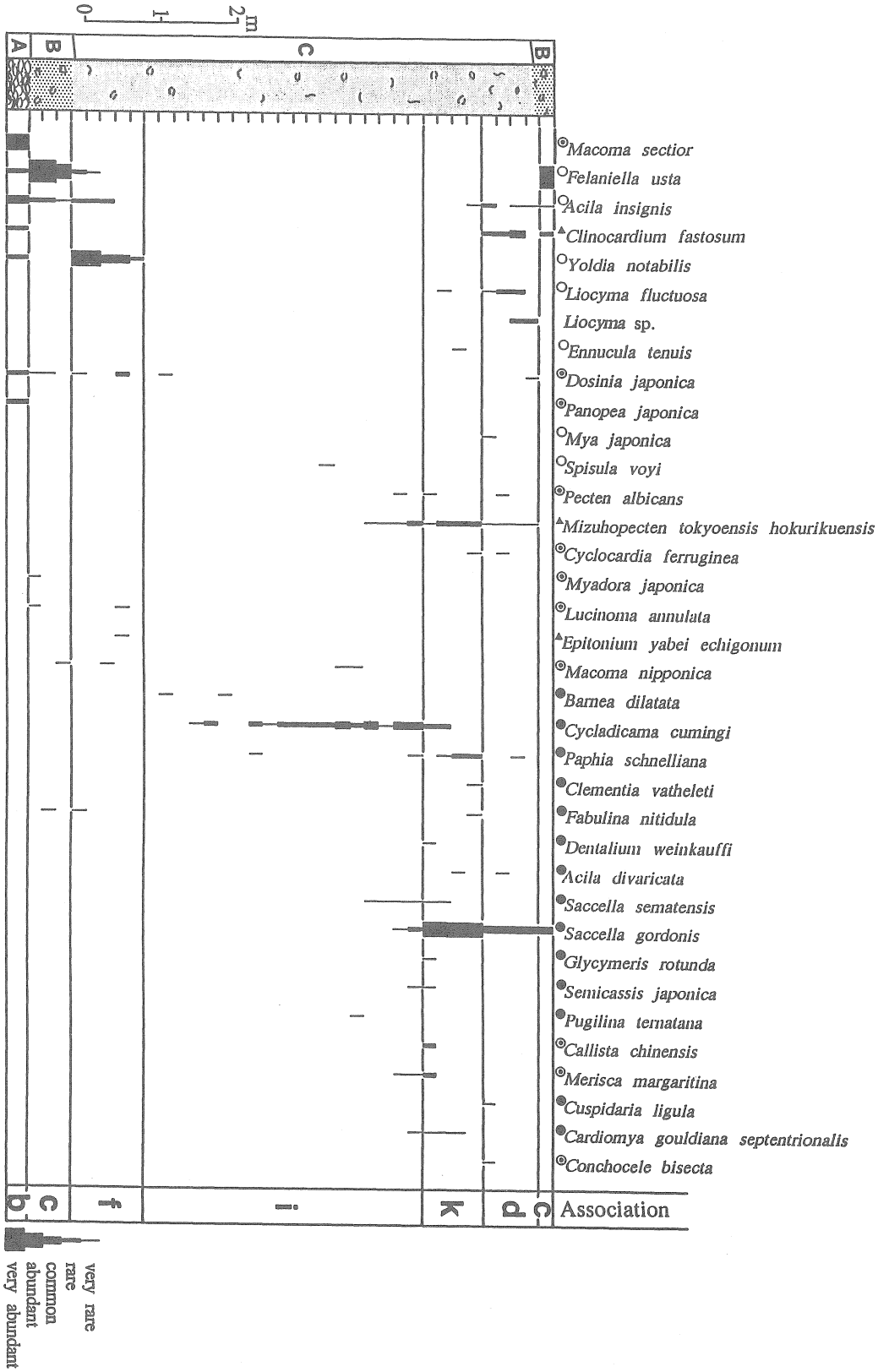

Fig. 11. Stratigraphic distribution and relative frequency of all molluscan species and molluscan fossil associations in the Cycle 9. See legend in Figs. 1, 2 and 3.

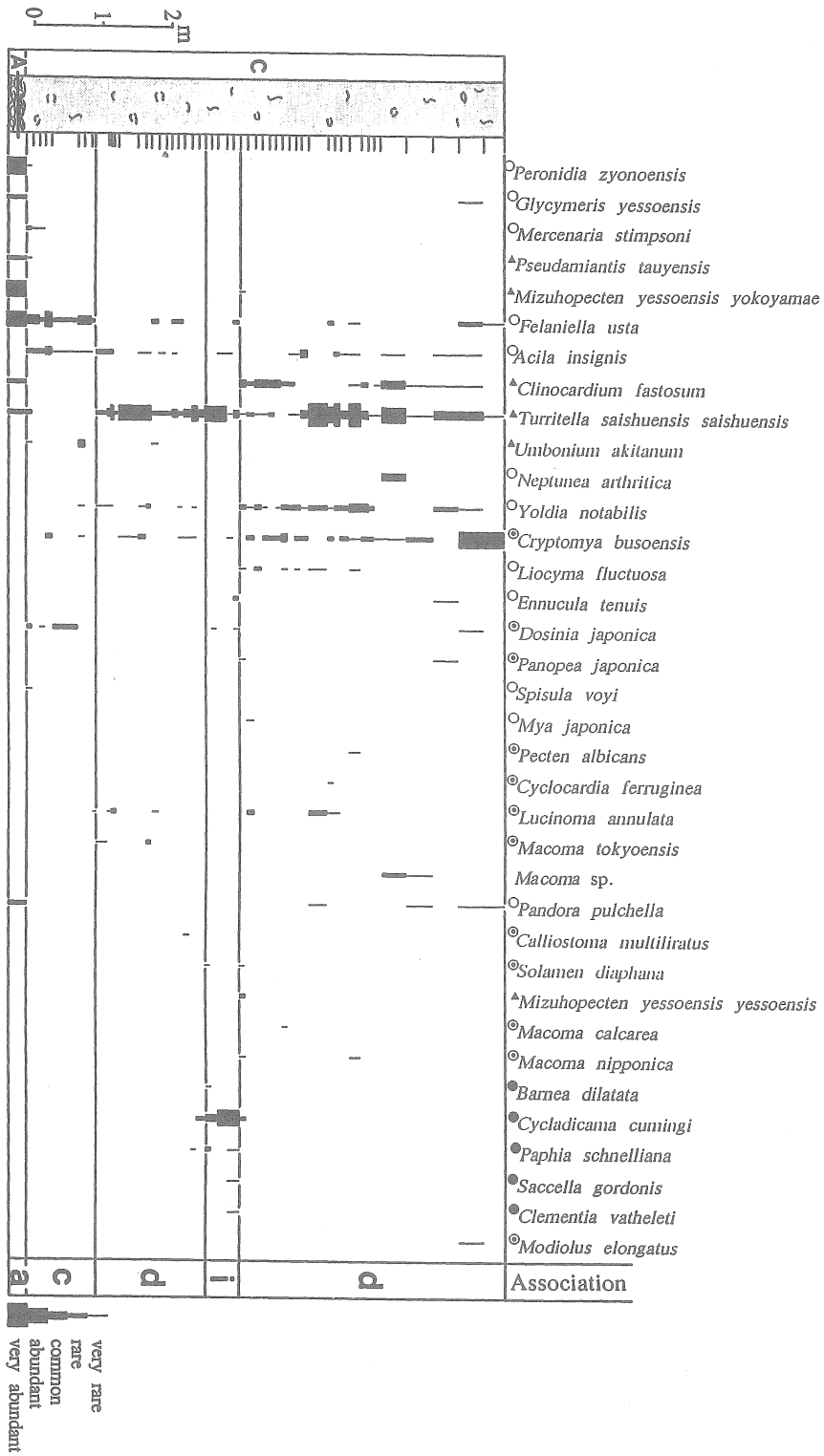

Fig. 12. Stratigraphic distribution and relative frequency of all molluscan species and molluscan fossil associations in the Cycle 10. See legend in Figs. 1, 2 and 3.

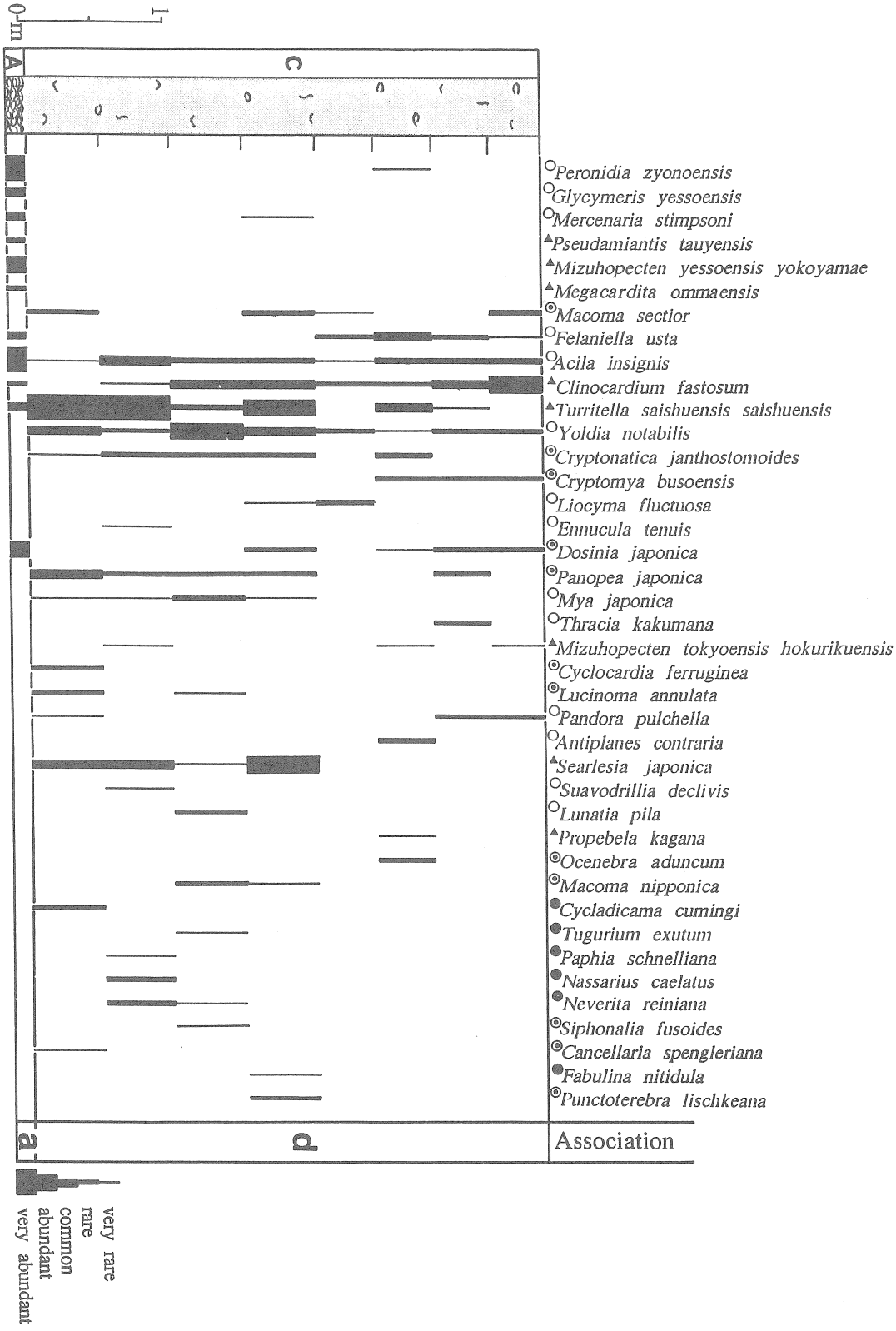

Fig. 13. Stratigraphic distribution and relative frequency of all molluscan species and molluscan fossil associations in the bed above the Cycle 10. See legend in Figs. 1, 2 and 3.

4. Conclusion

As it is evident in the figures above-mentioned, the cold- and warm-water species occur alternately in the most cycles. The former occurs within the basal shell bed, well-sorted sandstone and lower part of the muddy sandstone, whereas the latter in the upper part of the muddy sandstone, respectively. This reinforces the conclusions which were obtained from the analysis of the selected molluscan species (KITAMURA & KONDO, 1990).

Acknowledgments

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