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**STUDIES ON THE BIOLOGY AND ECOLOGY OF  
THE INTERTIDAL ANIMALS OF CHICHIJIMA ISLAND IN THE  
OGASAWARA (BONIN) ISLANDS**

**I. LIST OF COLLECTED SPECIES WITH COMMENTS ON SOME SPECIES**

**BY**

**AKIRA ASAKURA, SHIROOU NISHIHAMA, AND YASUO KONDO**

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# STUDIES ON THE BIOLOGY AND ECOLOGY OF THE INTERTIDAL ANIMALS OF CHICHIJIMA ISLAND IN THE OGASAWARA (BONIN) ISLANDS

## I. LIST OF COLLECTED SPECIES WITH COMMENTS ON SOME SPECIES

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AKIRA ASAKURA\*, SHIROU NISHIHAMA\*\*, AND YASUO KONDO\*\*\*

### INTRODUCTION

The Ogasawara (Bonin) Islands are subtropical, oceanic islands, located in the north west Pacific (Lat. 27° N, Long. 142° E). The nearest landmass is the Japan Islands situated ca. 1000 km to the north (Fig. 1). Many endemic species have been found in its terrestrial (Ono & Masuda, 1981; Ono & Sugawara, 1981; Kobayashi, 1978; Habe, 1969; Habe *et al.*, 1978) and marine environments (Okutani, 1986; Shigei, 1970; Hirohito, 1974; Habe *et al.*, 1978; Imajima 1970; Sugano, 1973; Ooishi, 1970; Kurata *et al.*, 1975).

The authors visited Chichijima Island of the Ogasawara Islands three times, in April 1986, May 1989, and June 1990. The purpose of the visits was to study the biological and ecological aspects of the intertidal animals there, which have received little attention to date.

In this paper, a list of species collected through those trips is presented, which includes one new species of a hermit crab, *Pagurus insulae* in Asakura (1991a), two new subspecies of gastropods, *Notoacmea schrenckii boninensis* in Asakura & Nishihama (1987a) and *Monodonta perplexa boninensis* in Asakura & Nishihama (1987b), and one new record of a hermit crab, *Calcinus guamensis* Wooster, from Japan (Asakura, 1991b).

### PREVIOUS WORK

Four main marine biological surveys of the Ogasawara Islands have been conducted; 1. Toba Aquarium [ June to July 1968](Toba Aq. & Asahi. Publ., 1970), 2. the Ministry of Education [ summer of 1968 ](Shigei, 1970), 3. Officials from the Ministry of Health and Welfare and the Tokyo Metropolitan government [ November to December 1968 ](Imajima, 1970), and 4. National Science Museum [ 1975 to 1976 ](Habe *et al.*, 1978). Several other works, in particular taxonomic works, are well documented in Habe *et al.*, (1978), Ooishi (1970), Takeda & Miyake (1976), and Eldredge (1975).

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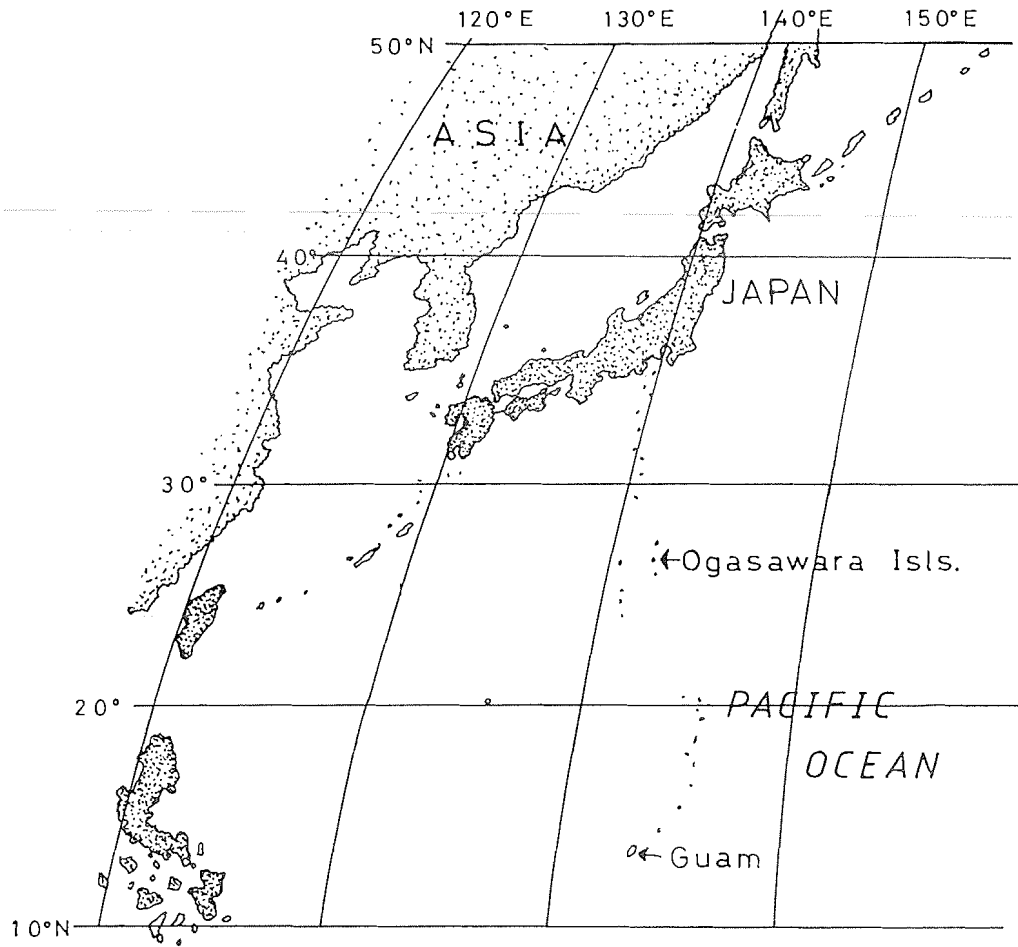


Fig. 1. Location of the Ogasawara Islands.

## PRESENT WORK

Judging from the photographs of the Chichijima island taken in 1968 (in Toba Aq. and Asahi. Publ., 1970), the landscape has changed drastically. In particular, the west coast has recently been rapidly developed. The natural coastal zones in the inner part of Futami Bay (the largest bay in the island) have also been damaged in order to construct a larger harbor with concrete-protected shore lines, and some species of intertidal invertebrates were exterminated (Asakura & Nishihama, 1988).

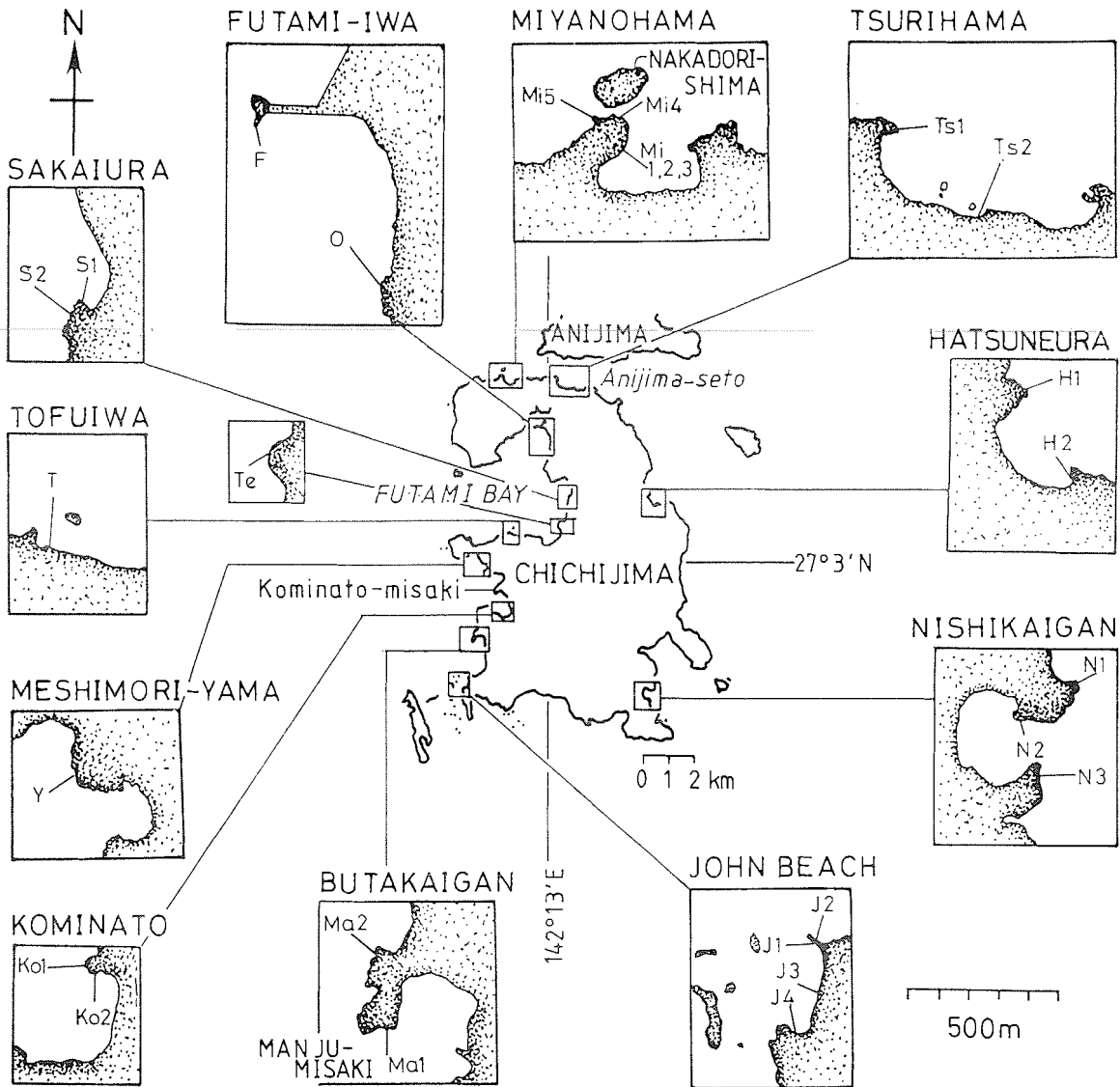
In our investigations, we quantitatively sampled many invertebrates from whole coastal areas of Chichijima. Since the destruction of those coastal areas continues, this sample will have the value of recording for posterity the animals that inhabited this region. Many rare and endemic species inhabit the islands, and we feel that the conservation of these coastal areas is important.

## LOCATION OF SAMPLING POINTS

All sampling points were located in the intertidal zones of rocky shores on the coast of Chichijima Island (Fig. 2). Detailed descriptions of topography of each site have been already published in Asakura & Nishihama (1987a,b; 1988) and Asakura *et al.* (1991). Collections were made at low tide during the spring tide. Samples were preserved in 10% formalin solution, brought to the laboratory and identified to species.

Following references were used for identification; Mollusca (Okutani, 1986; Habe & Okutani, 1975), Crustacea (Miyake, 1982, 1983), Annelida (Utinomi, 1975), and Echinodermata (Utinomi, 1975). Unidentified species were sent to an authority for each taxon, and these identifications were followed.

**ACKNOWLEDGEMENTS** ---- We wish express our heartfelt thanks to the following persons for identifying specimens and contributing valuable information: Dr. T. Habe, President of the Malacological Society of Japan (Mollusca), Dr. S. Miyake, President of the Carcinological Society of Japan (Crustacea, Anomura), Dr. K. Sakai, Professor of Shikoku Women's University (Crustacea, Anomura), Dr. K. Baba, Professor of Kumamoto University (Crustacea, Anomura), Dr. Y. Miya, Professor of Nagasaki University (Crustacea, Macrura), Dr. M. Takeda, National Science Museum (Crustacea, Brachyura), Dr. T. Yamaguchi, Associate Professor of Chiba University (Crustacea, Cirripedia). We also express our sincere appreciation to Professor T. Yanagisawa, the Ogasawara Research Committee of Tokyo Metropolitan University, Mr. K. Nishimura, the Ogasawara Fishery Center, Mr. Y. Kurata, the Ogasawara Marine Center, Mr. Y. Matsumoto, Toba Aquarium, and Dr. B.D. Smith, Guam University Marine Laboratory, for their valuable suggestions, advises, and aid in the bibliographical survey. Thanks are also due to Mr. T. Kurozumi, Natural History Museum and Institute, Chiba and an anonymous reviewer for useful comment on the manuscript. Staffs of the Ogasawara Youth Hostel and T. Nakajima, the Urayasu Official, kindly assisted us in our field works. This work is a part of results of the special project on the "Investigation of the Nature of the Boso, Izu, Ogasawara, and Mariana Archipelagos", financially supported by the grant of the Natural History Museum and Institute, Chiba from the Educational Department of Chiba Prefecture.



**Fig. 2.** Locations of the sampling points along the coast of the Chichijima Island. Abbreviations of the site names are; K: Kiyose, F: Futamiiwa, O: Okumura, S1: Sakai-ura-1, S2: Sakaiura-2, Mi1: Miyanohama-1, Mi2: Miyanohama-2, Mi3: Miyanohama-3, Mi4: Mi-yanohama-4, Mi5: Miyanohama-5, Ts1: Tsurihama-1, Ts2: Tsurihama-2, H1: Hatsuneura-1, H2: Hatsuneura-2, N1: Nishikaigan-1, N2: Nishikagan-2, N3: Nishikaigan-3, J1: John Beach-1, J2: John Beach-2, J3: John Beach-3, J4: John Beach-4, Ma1: Manjyumisaki-1, Ma2: Manjyumisaki-2, Ko1: Kominato-1, Ko2: Kominato-2, Te: Tengu-bana, T: Toufuiwa, Y: Yagyusan

## COMMENTS ON SOME SPECIES

### 1. *Megabalanus occator* (Darwin) (Fig. 3A)

Common to the lower intertidal zone of wave-exposed rocky shores and one of the most important organisms characterizing the zonation pattern of wave-exposed rock platforms (Asakura *et al.*, 1991). This species has also been reported from the Tokara Islands and further south, but details of the geographical distribution have not yet been fully studied (Yamaguchi, 1986).

### 2. *Callianidea typha* H. Milne Edwards

Two specimens of this ghost shrimp were collected under a boulder in the lower intertidal zone of the Yagyu-san coast. This species has been reported from Bismark Island (type locality), Kagoshima, Yaeyama Islands, and the Tokara Islands (Miyake, 1956). Recently Oishi (1970) recorded *Callianidea planocula* Melin from Futami Bay of Chichijima Island, although the species may be a synonym of *C. typha* (K. Sakai, personal communication).

### 3. *Pagurus insulae* Asakura (Fig. 3B)

A dominant hermit crab species of the intertidal zones from sheltered to exposed rocky shores. This species resembles *P. geminus*, but *P. geminus* has the single large tubercle on ventral surface of the merus of each cheliped, which this species does not have. One of the authors of this paper made a description of this as a new species in Asakura (1991a).

### 4. *Leptodius davaoensis* Ward (Fig. 3C)

(=*Leptodius leptodon* Forest & Guinot; Takeda & Miyake, 1976). Commonly found under the boulders. Takeda (1980) examined the crab specimens described by Ward in 1939 and 1941 (preserved in Am. Mus. Nat. Hist.) and revealed that *L. davaoensis* Ward, 1941 was conspecific with *L. leptodon* Forest & Guinot, 1961.

### 5. *Ischnochiton computus f. computus* Gould (Fig. 3D)

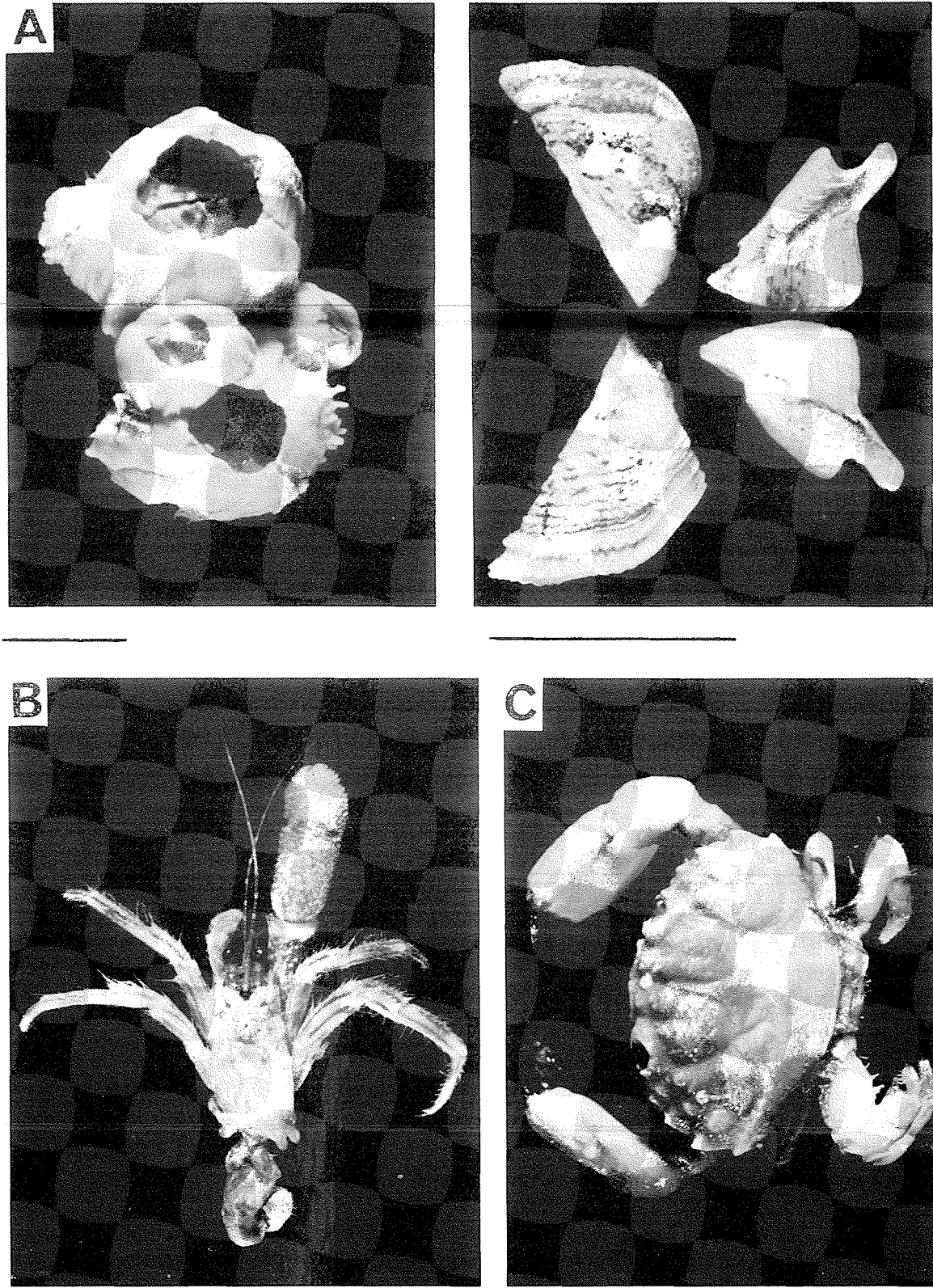
Inhabiting under boulders in the lower intertidal zone. Morphological characters of the specimens are similar to *Ischnochiton computus* Gould from the temperate Japanese region. However, all of the shells collected from Ogasawara have green color with no obvious patterns. In contrast, the shells from the Japanese temperate region have several distinct color patterns.

### 6. *Notoacmea schrenckii boninensis* Asakura & Nishihama (Fig. 3E)

*N. schrenckii* is widely distributed in temperate Japanese waters. Specimens from Chichijima Island are small in size and have a different shell color pattern from those in the temperate region. We made a description of this limpet as a new subspecies of *N. schrenckii* in Asakura & Nishihama (1987a).

### 7. *Monodonta australis* Lamarck (Fig. 3F)

A very abundant snail in boulder beaches. Two types of shells were found; a tall shell with numerous granules on the surface (right in Fig. 3F) and a short shell with smooth surface (only this type has been known to date [Takenouchi, 1986; Habe & Okutani, 1975])(left in Fig. 3F). The former was found in wave-sheltered beaches such as Kiyose and Okumura, and the latter was found over a wider range, from the wave-moderate to very exposed beaches. This species has also been reported from Hong Kong (Morton & Morton, 1983) and southern Africa (Branch & Branch, 1981), however there has been no record from Okinawa (the Ryukyu Islands). Recently K. Takenouchi (personal communication) found that morphological characteristics of the specimens from Ogasawara (the short type) did not fit those in the original description as well as those specimens collected from Hong Kong. The specimens may belong to a new endemic which requires taxonomic reconsideration.



**Fig. 3.** Selected species characterizing the intertidal zones of the Chichijima Island. Horizontal bars indicate 1 cm. **A.** *Megabalanus occator* (Darwin); left: outer view, right: scutum and tergum **B.** *Pagurus insulae* Asakura. **C.** *Leptodius davaoensis* Ward.

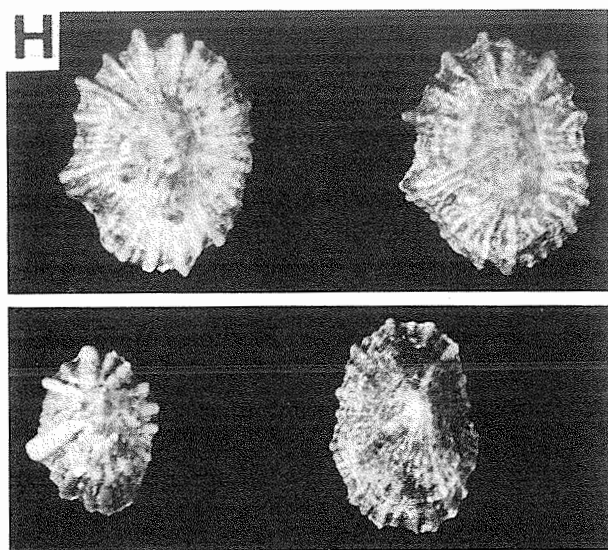
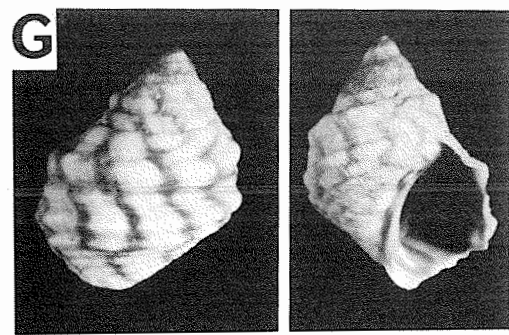
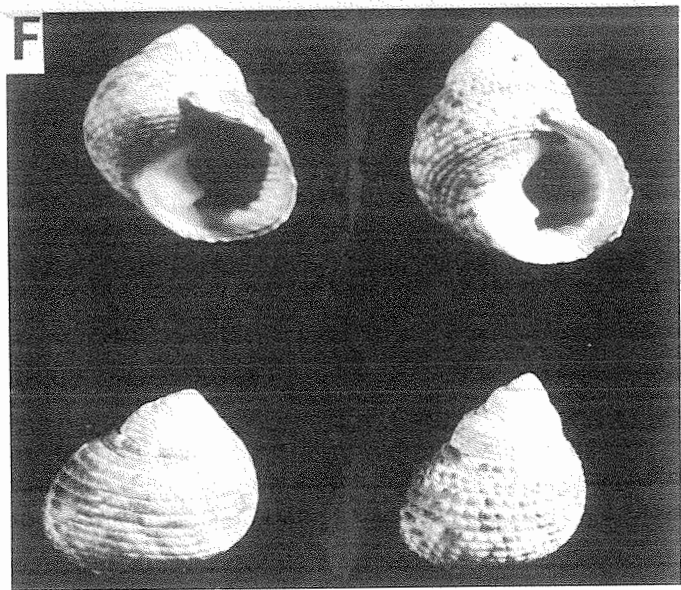
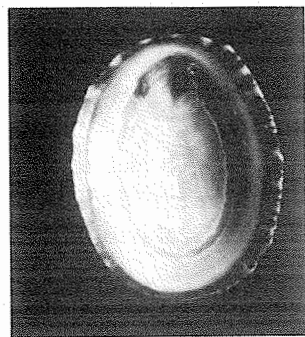
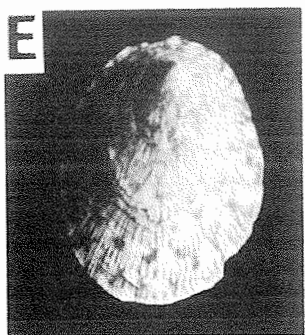
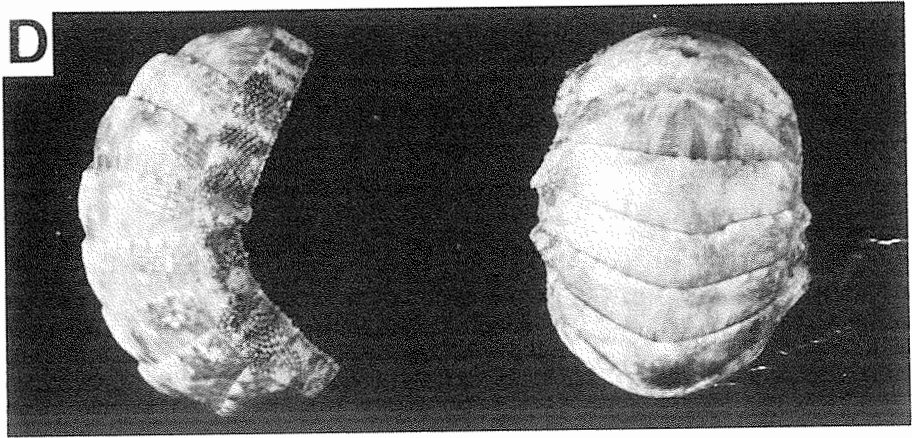


Fig. 3 (continued) D. *Ischnochiton comptus* f. *comptus* Gould. E. *Notoacmea schrenckii boninensis* Asakura & Nishihama. F. *Monodonta australis* Lamarck G. *Nodilittorina* sp. H. *Siphonaria* sp.



**8. *Monodonta perplexa boninensis* Asakura & Nishihama**

Abundant in boulder beaches. This subspecies is endemic to Ogasawara. Only the name was given by Pilsbry, but no valid taxonomic description was made. We described this species in comparison with *M. perplexa perplexa* in Asakura & Nishihama (1987b).

**9. *Nodilittorina* sp. (Fig. 3G)**

Very abundant in the upper rocky intertidal zones (Asakura *et al.*, 1991). In Japan and its adjacent waters, this species can be found only in Ogasawara, except in a very few cases in Okinawa (Habe, 1951; Nishihira, 1977). Oyama (1940) and Oyama & Takemura (1963) identified this species as *Nodilittorina miliaris*. However, Rosewater (1970) identified it as *N. leucosticta feejeensis* (Reeve), and then Rosewater & Kadolsky (1981) synonymized it as *N. quadricincta feejeensis*. Asakura & Kurozumi (1991) discussed morphological difference between the true *N. quadricincta feejeensis* and specimens from the Ogasawara. We believe that the species in the Ogasawara is endemic and taxonomic re-examination is needed.

**10. *Siphonaria* sp. (Fig. 3H)**

Inhabiting abundantly the rock platform surfaces and underside of boulders (Asakura *et al.*, 1990, 1991). The shell morphology of this limpet is variable. Kurata *et al.* (1969) and Shigei (1970) also recorded this species from Ogasawara. Morphologically, its shell is different from any other *Siphonaria* species in Japan and its adjacent waters, and further taxonomic study is needed (Asakura *et al.*, 1991).

## LIST OF SPECIES

Abbreviations of the name of the sampling sites are as follows (see Fig. 2 for the location of each site). K: Kiyose, F: Futamiiwa, O: Okumura, S1: Sakaiura-1, S2: Sakaiura-2, Mi1: Miyanohama-1, Mi2: Miyanohama-2, Mi3: Miyanohama-3, Mi4: Miyanohama-4, Mi5: Miyanohama-5, Ts1: Tsurihama-1, Ts2: Tsurihama-2, H1: Hatsuneura-1, H2: Hatsuneura-2, N1: Nishikaigan-1, N2: Nishikaigan-2, N3: Nishikaigan-3, J1: John Beach-1, J2: John Beach-2, J3: John Beach-3, J4: John Beach-4, Ma1: Manjyumisaki-1, Ma2: Manjyumisaki-2, Ko1: Kominato-1, Ko2: Kominato-2, Te: Tngubana, T: Toufuiwa, Y: Yagyusan

Small capitals after the abbreviations of the site names indicate the shore types; r: steep rock platform, p: rocky shore with many tide pools, b: boulder beach, be: beachrock.

Asterisks indicate cases where only vacant shells were collected, and, for reference, species recorded solely from vacant shells are listed in Appendix 1. Specimens are deposited in the National Science Museum, Tokyo [NSMT], Amakusa Marine Biological Laboratory of Kyushu University [AMBL], and Shikoku Women's University [SWU]. Other specimens, which are not particularly indicated, are deposited in the Natural History Museum and Institute, Chiba [CBM].

Phylum Arthropoda  
Class Crustacea  
Subclass Cirripedia  
Order Thoracica  
Suborder Balanomorpha

Family Chthamalidae

*Chthamalus challengeri* Hoek

F-r, O-r, S1-r, S2-r, Te-r, T-r, Y-r, Mi1-r, Mi2-r, Mi3-r, Mi4-r, Mi5-r, Ts1-r, Ts2-r, H1-r,  
H2-r, J1-r, J2-r, J3-be, N1-r, N2-r, N3-r, Ko1-r, Ko2-r, Ma1-r, Ma2-r

**Family Tetracitidae**

*Tetracita squamosa japonica* Pilsbry

Y-r, Ts1-r

**Family Balanidae**

*Megabalanus occator* (Darwin)

S2-r, Te-r, T-r, Y-r, Ts1-r, H1-r, N1-r, N2-r, Ma2-r

Subclass Malacostraca

Order Isopoda

Suborder Flabellifera

**Family Cirolanidae**

*Cirolana harfordi japonica* Thielemann

S2-r

Order Decapoda

Suborder Natantia

**Family Alpheidae**

*Alpheus pacificus* Dana

O-b, S1-b, Y-b

Suborder Reptantia

Infraorder Anomura

**Family Porcellanidae**

*Petrolisthes japonicus* (De Haan)

K-b, O-b, S1-b, Y-b, Ma-b

**Family Callianassidae**

*Callianidea typa* H. Milne Edwards [SWU]

Y-b

**Family Diogenidae**

*Calcinus laevimanus* (Randall)

S1-p, S2-p, S1-b, T-p, Y-p, Y-b, Ha1-p, Ha2-p, Ts1-p, Ts2-p, J1-p, J2-p, J3-be, Ma1-p,

Mi3-p, Mi4-p, Mi5-p, N1-p, N2-p, N3-p, H1-p, H2-p

*Calcinus gaimardii* (H. Milne Edwards)

O-p

*Calcinus latens* (Randall)

O-p, S1-p, T-p, Y-p, N2-p, N3-p

*Calcinus elegans* (H. Milne Edwards)

O-p, T-p, Y-p, J1-p, J2-p, Ma1-p, H2-p, Ts1-p, Ts2-p

*Calcinus guamensis* Wooster

Ts2-r

*Calcinus* sp. 1

O-p, T-p, Y-p, Ma1-p, H1-p, H2-p, Ts1-p, Ts2-p

*Calcinus* sp. 2 (? *C. nitidus* Heller)

Ts2-r

*Clibanarius humilis* Dana

K-b, O-b, O-p, S1-p, S1-b, T-p, Y-b, Y-p, H2-p, J1-p, J2-p, Ma1-p, Ma1-b, Mi1-b, M4-

p, Mi5-p, N2-p, N3-p, Ts1-p, Ts2-p

**Family Paguridae**

*Pagurus insulae* Asakura

K-b, O-p, O-b, S1-p, S1-b, T-p, Y-b, Y-p, Ko2-r, Ma1-p, Mi1-p, H2-p, N2-p, N2-b, N3-p,

Ts1-p, Ts2-p

Infraorder Brachyura

**Family Xanthidae**

*Leptodius davaoensis* Ward

K-b, O-b, S1-b

*Xanthias lamarckii* (H. Milne Edwards)

O-b, S1-b

**Family Menippidae**

*Epixanthus corrosus* A. Milne Edwards

K-b

**Family Grapsidae**

*Metopograpsus messor* (Forskål)

K-b

*Gaetice depressus* (De Haan)

K-b, O-b, O-p, S1-b, S1-p, Y-b, Y-p

*Sesarma dehaani* H. Milne Edwards

mouth area of Kiyose river

**Phylum Mollusca**

**Subphylum Amphineura**

**Class Polyplacophora**

**Order Neoloricata**

**Suborder Ischnochitonina**

**Family Ischnochitonidae**

*Ischnochiton comptus* f. *comptus* (Gould) [AMBL]

O-b, O-p, S1-b, Y-b

**Family Chitonidae**

*Onithochiton hirasei* Pilsbry [AMBL]

O-p

*Acanthopleura japonica* (Lischke) [AMBL]

O-r, S1-r, S2-r, Te-r, T-r, Y-r, Mi2-r, Mi4-r, Ts1-r, H1-r, H2-r, J1-r, J2-r, J4-l, N1-r, Ko2-r, Ma1-r, Ma2-r

**Suborder Acanthochitonina**

**Family Acanthochitonidae**

*Acanthochiton rubrolineatus* (Lischke) [AMBL]

O-p

**Subphylum Conchifera**

**Class Gastropoda**

**Subclass Prosobranchia**

**Order Archaeogastropoda**

**Family Patellidae**

*Patella flexuosa* Quoy & Gaimard

Ma1-r, Ma2-r

*Cellana enneagona* (Reeve)

O-p, O-r, O-b, S1-r, S2-r, S1-p, S1-b, T-r, T-p, Y-r, Y-p, Y-b, Ts2-r, H2-r, J3-be, Ma2-r

*Cellana mazatlandica* (Sowerby) [AMBL, CBM]

O-r, S1-r, Te-r, T-r, Y-r, J1-r, J2-r, Ko2-r

**Family Acmaeidae**

*Notoacmea schrenckii boninensis* Asakura & Nishihama [NSMT, CBM]

O-b, S1-b, Y-b, Mi1-b, Ts1-b, H2-b, N2-b, Ma1-b, Ko2-b

*Notoacmea* cf. *concinna* (Lischke)

Y-b

## Family Trochidae

*Diloma suavis* (Philippi)

O-r, S1-p, S1-r, S2-r, T-p, T-r, Y-p, Y-r, Ma2-r

*Monodonta australis* Lamarck

K-b, F-r, O-b, O-r, O-p, S1-b, S1-p, S1-r, Te-r, T-p, T-r, Y-b, Y-p, Y-r

*Monodonta perplexa boninensis* Asakura & Nishihama [NSMT, CBM]

Y-b, Y-p\*, T-p\*, O-p\*

*Clanculus denticulatus* (Gray) ?

O-b, O-p\*, T-p\*, Y-p

*Talopena vernicosa* (Gould)

S1-b, S1-p\*

## Family Turbinidae

*Lunella cinerea* (Born)

O-b, S1-b, S1-p\*, O-p\*

## Family Neritidae

*Nerita (Ritena) plicata* Linnaeus

O-r, Te-r, K-b\*

*Nerita (Theliostyla) squamulata* (Récluz)

O-b, S1-b

*Nerita (Theliostyla) albicilla* Linnaeus

O-b, O-p, S1-b, S1-p, T-p, Y-b, Y-p, H2-b, N2-b, Mal-b, Ko2-b

*Nerita (Amphinerita) polita* Linnaeus

Y-b

## Order Mesogastropoda

## Family Littorinidae

*Nodilittorina pyramidalis* (Quoy & Gaimard)

F-r, O-p, O-r, S1-r, S1-p, S2-r, Te-r, T-p, T-r, Y-p, Y-r, Y-b\*, Mi1-r, Mi2-r, Mi3-r, Mi4-r, Mi5-r, Ts1-r, Ts2-r, H1-r, H2-r, J1-r, J2-r, J4-l, N1-r, N2-r, N3-r, Kol-r, Ko2-r, Mal-r, Ma2-r

*Nodilittorina* sp.

F-r, O-p, O-r, S1-r, S1-p, Te-r, T-p, T-r, Y-p, Y-r, Y-b\*, Mi1-r, Mi2-r, Mi4-r, Mi5-r, Ts1-r, Ts2-r, H1-r, H2-r, J1-r, J2-r, J3-be, N1-r, N2-r, N3-r, Kol-r, Mal-r, Ma2-r

*Littoraria pintado* (Wood)

O-p, O-r, S1-r, S1-p, S1-b\*, S2-r, Te-r, T-p, T-r, Y-p, Y-r, Mi1-r, Mi2-r, Mi4-r, Ts2-r, J4-l, N1-r, N3-r,

*Littoraria coccinea* (Gmelin)

S1-r, S1-b, S2-r

## Family Vermetidae

*Dendropoma* sp.

Ts1-r, Ts2-r, H1-r, H2-r, N1-r, N2-r, N3-r, Mal-r

*Serpulorbis imbricatus* (Dunker)

O-r, O-p, S1-r, S1-p, S1-b\*, T-p, Y-p, Mi3-r, H1-r, H2-r, N1-r, N2-r, N3-r, Kol-r, Ko2-r, Ma2-r

*Serpulorbis daidai* Schuwimmer & Nishiwaki

Mi4-r, J2-r, Ko2-r

*Vermetus* sp.

Mi2-r, Mi5-r, J1-r, J2-r, J3-be, Mal-r

## Family Planaxidae

*Angiola inepta* (Gould)

O-b, O-p, S1-b, S1-p, T-p, Y-b, Y-p

*Supplanaxis niger* (Quoy & Gaimard)

S1-b, Y-p, T-p

**Family Naticidae**

*Natica lurida* (Philippi)

S1-b, S1-p\*, T-p\*, Y-b\*, Y-p\*,

**Order Neogastropoda**

**Family Muricidae**

*Nassa sarta* (Bruguière)

Y-p, T-p\*, O-p\*

*Mancinella siro* (Kuroda)

O-p\*, H1-r

*Mancinella intermedia* (Kiener)

Y-p, O-p\*, Mi3-r, N1-r

*Drupa ricinus ricinus* (Linnaeus)

O-b, O-p, S1-b, S1-p, T-p, Y-p, Y-b

*Drupa ricinus hadari* Emerson & Cernohorsky

Y-p, T-p\*

*Cronia (Muricodrupa) fiscella* (Gmelin)

Y-p

*Maculotriton serriialis* (Deshayes)

Y-p, T-p\*

*Morula striata* (Pease)

O-p, S1-p, T-p, Y-p

*Morula granulata* (Duclos)

O-b, O-p, T-p, Y-p, H1-r, H2-r, N2-r, N3-r, Ma2-r

*Morula borealis* (Pilsbry)

T-p, Y-p

*Thais (Stramonita) aculeata* (Deshayes)

Y-p

*Purpura panama* (Röding)

Hi-r

**Family Pyrenidae**

*Zafra pumila* (Dunker)

S1-b, S1-p, O-b

**Family Buccinidae**

*Polia undosa* (Linnaeus)

O-p\*, S1-b, S1-p, T-p, Y-b, Y-p

**Family Mitridae**

*Strigatella fastigium* (Reeve)

O-p\*, Y-p

**Subclass Opisthobranchia**

**Order Cephalaspidea**

**Family Haminoeidae**

*Smaragdinella calyculata* (Broderip & Sowerby)

H1-r, J1-r, J4-r

**Subclass Pulmonata**

**Order Basommatophora**

**Suborder Archaeopulmonata**

**Family Siphonariidae**

*Siphonaria* sp.

O-b, O-p, O-r, S1-b, S1-p, S1-r, T-r, T-p, Y-r, Y-p, Mi1-r, Mi2-r, Mi3-r, Mi5-r, Ts1-r  
Ts2-r, H1-r, H2-r, J1-r, J2-r, J3-be, N1-r, N2-r, N3-r, Ko1-r, Ko2-r, Mal-r, Ma2-r

Class Bivalvia

Subclass Pteriomorpha

Order Mytiloida

Family Mytilidae

*Hormomya mutabilis* (Gould) [AMBL, CBM]

O-r, S1-r, S2-r, T-r, Mi4-r, Mi5-r, H1-r, Ko1-r, Ko2-r

Family Pteriidae

*Pinctada* sp. [AMBL, CBM]

H1-r

Family Isognomonidae

*Isognomon nucleus* Lamarck

F-r, O-r, S1-r, S2-r, T-r, Mi1-r, Mi2-r, Mi3-r, Mi5-r, J1-r, Ko2-r, Ma2-r

Family Ostreidae

*Saccostrea mordax* (Gould)

F-r, O-r, S-r, T-r, Y-r, Mi4-r, Mi5-r, Ts1-r, H1-r, J2-r, N1-r, Ko1-r, Ko2-r

Subclass Eulamellibranchia

Order Heterodonta

Family Lasaeidae

*Lasaea cf undulata* (Gould)

S-r

Family Tridacnidae

*Tridacna maxima* (Roding)

O-r, O-p, S-r, S-p, T-p, T-r

Phylum Annelida

Class Polychaeta

Family Serpulidae

*Pomatoleios kraussii* (Baird)

F-r, O-r, O-b, O-p, S-r, S-b, S-p, T-r, T-p, Y-r, Y-p

Family Sabellariidae

*Idanthyrsus pennatus* (Peters)

J4-l, Mal-r

Phylum Echinodermata

Subphylum Asterozoa

Class Ophiuroidea

Order Gnathophiurida

Family Ophiocomidae

*Ophiocoma scolopendrina* Lamarck

O-p, S-p, Y-p

Subphylum Echinozoa

Class Echinoidea

Subclass Euechinoidea

Order Phymosomatoida

Family Stomechinoidae

*Stomopneustes variolaris* (Lamarck)

S-r, T-r, Y-r

## Order Aulodonta

## Family Diadematidae

*Echinothrix diadema* (Linnaeus)

N3-r

## Order Camarodonta

## Family Echinometridae

*Echinometra mathaei* (Blainville) [type B in Uehara *et al.*, (1990)] [AMBL, CBM]

O-b, S-b, S-r, T-r, T-p, Y-r, Y-p, Mi4-r, Ts1-r, N1-r, N2-r, Ko1-r, Ma1-r

*Echinometra oblonga* (Blainville)

H1-r, H2-r, J4-l, N1-r, N2-r, N3-r, Ko1-r, Ma1-r, Ma2-r

*Heterocentrotus mammillatus* (Linnaeus) [AMBL, CBM]

S-p, T-p, Y-p

*Colobocentrotus mertensi* (Brandt)

Y-r

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**Appendix 1.** The list of gastropods (Mollusca) species recorded solely from vacant shells. They were mainly used by the intertidal hermit crabs as their host shells. All of them are deposited in the Natural History Museum and Institute, Chiba (CBM).

**Subclass Prosobranchia Order Archaeogastropoda: Family Liotiidae;** *Liotina peroni* (Kiener), S-b, O-p; *L. semiclathratula* (Schrenck), S-b, Y-p. **Family Trochidae;** *Calliostoma simodense* Ikebe, T-p; *Ethalia guamensis* (Quoy & Gaimard), O-b; *Clanculus margaritarius* (Philippi) Y-p; *Clanculus* sp., S-b; *Trochus maculatus* Linnaeus, S-p, O-p; *Tectus* sp., S-p, O-p. **Family Turbinidae;** *Homalopoma nocturnum* (Gould), S-p; *Collonista glareosa* (Gould), O-p; **Order Mesogastropoda: Family Rissoinidae;** *Alvania ogasawarana* Pilsbry, Y-p. **Family Turritellidae;** g. sp., S-b. **Family Cerithiidae;** *Clypeomorus chemnitziana* (Pilsbry), S-b, Y-p, O-p; *C. trailli* (Sowerby), S-b, O-p; *C. humilis* (Dunker), K-b, O-b; *Clypeomorus* sp.1, K-b, O-b, O-p, S-b, S-p, Y-p; *Clypeomorus* sp.2, O-b, O-p, S-b, Y-p; *Conocerithium bavayi* (Vignal), S-b; *Ischnocerithium* sp., K-b. **Family Strombidae;** *Canarium mutabilis* (Swainson), T-p, S-p; *C. microurceum* Kira, T-p. **Family Cypraeidae;** *Monetaria moneta* (Linnaeus), Y-p; *M. annulus* (Linnaeus), Y-p; *Erosaria helvola* (Linnaeus), S-p; *Ravitrona caputserpentis* (Linnaeus), Y-p. **Family Cymatiidae;** *Septa* sp., Y-p, O-p; *Lampusia aquatilis* (Reeve), Y-p; *Turritriton kiiensis* (Sowerby), O-p. **Family Bursidae;** *Bursa corrugata* (Perry), Y-p; *B. bufonia* (Linnaeus), Y-p, O-p. **Order Neogastropoda : Family Muricidae;** *Pascula benedicta* (Melvill & Standen), T-p; *Drupella cornus* (Röding), O-p; *Cronia (Muricodrupa) fusca* (Küster), K-b; *C. (Usilla) fusconigra* (Pease), Y-p, T-p; *Morula uva* (Röding), Y-p; *Thais (Reishia) pseudodiadema* (Yokoyama), T-p; *Ergalatax contractus* (Reeve), K-b. **Family Coralliophilidae;** *Coralliophila squamosissima* (Smith), T-p, Y-p; *Coralliophila* sp., O-p. **Family Pyrenidae;** *Pyrene testudinaria* (Link), S-b, S-p, T-p, Y-b, Y-p; *P. flava* (Bruguière), Y-p; *Euplica versicolor* (Sowerby), K-b, O-b, O-p, S-b, S-p, T-p; *Anachis misera nigromaculata* (Tomlin), Y-p; *Zafrona lifuana* (Hervier), T-p. **Family Buccinidae;** *Enzinopsis menkeana* (Dunker), O-p, S-p. **Family Nassariidae;** *Telasco velatus* Gould, O-p, T-p; *Zeuxis hepaticus* (Pyltney), T-p; *Zeuxis* sp.1, S-b; *Zeuxis* sp.2, Y-p; *Alectrion glans suturalis* (Lamarck), K-b, O-b, O-p, S-b, S-p, Y-p. **Family Fascioliidae;** *Latirus kandai* Kuroda, K-b, S-b, Y-p; *Latirulus nagasakiensis* (Smith) ?, K-b, Y-p; *Benimakia fastiginda* (Reeve), S-b. **Family Mitridae;** *Strigatella scutulata* (Gmelin), T-p; *S. litterata* (Lamarck), O-p; *Vexillum unifasciatum* (Wood), O-p. **Family Turridae;** *Lienardia planilabrum* (Reeve) ?, Y-p; *Lienardia* sp.1, O-p; *Lienardia* sp.2, S-p. **Family Conidae;** *Virgiconus flavidus* (Lamarck), O-p; *Virroconus fulgetrum* (Sowerby), T-p; *V. sponsalis* (Hwass), Y-p; **Family Terebridae,** g. sp., O-b, **Order Heterogastropoda: Family Epitoniidae;** *Gyroscaia perplexa* (Pease), Y-b; *Spiniscala japonica* (Dunker), S-b. **Family Architectonicidae;** *Heliacus variegatus* (Gmelin), K-b, O-b. **Subclass Opisthobranchia: Order Pyramidellomorpha: Family Pyramidellidae;** *Odostomia* sp., Y-b; *Tiberia* sp., O-p. **Order Cephalaspidea: Family Acteonidae;** *Punctacteon fabreanus* (Grosse), S-p, T-p.