JOURNAL OF THE COLLEGE OF SCIENCE, TOKYO IMPERIAL UNIVERSITY.
VOL. XLV., ART. 3.

Molluscan Remains from the Lowest Part of the Jô-Ban Coal-Field.

By

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With 5 Plates.

Not very far from Tokyo, to the north-north-east, where the Pacific coast of Central Japan runs nearly due north and south, there is a narrow strip of land lying between the sea on one side and the old mountains of Palaeozoic and pre-Palaeozoic rocks on the other composed of a Tertiary Formation. This formation produces coal in many places. On this account, these strata are collectively known under the name of the "Jô-Ban[1] Coal-field," from the names of the two provinces in which they are scattered.

The geology of this coal-field which is intersected by numerous faults, large and small, has been fully studied by Dr. S. Tokunaga, professor of geology in the University of Waseda, and made known in one of the scientific publications of the same university under the title: "On the Jô-Ban Coal-Field."[2]

According to Dr. Tokunaga, the field is about eighty kilometres from north to south and four to twenty-four kilometres from east to west, extending over the districts of Futaba, Iwaki and Taga, the first two of which are in the province of Iwaki and the last in Hitachi. The general strike of the rock-layers runs north-south with dip directed to east, the angle varying from a few degrees in the uppermost part to more than fifteen in the lowest. The whole formation, when all the layers are fully represented, he estimates as more than 700 metres thick. Near Yumoto which is taken as one of the thickest places, the following layers are counted in a descending order:

1 *Shirado (White-Earth)-Beds.* The uppermost layer is a thick sand of a reddish hue below which there is a tufaceous sandstone changing in

1) Jô-Ban is a combination of the first syllables of Jôshiu (or Hitachi) and Banshiu (or Iwaki).

2) Written in Japanese. Memoirs of the College of Science and Engineering, Waseda University, No. 1, 1922.

many places to a pure tuffite. The sandstone may contain a great quantity of volcanic lapilli, or may alternate with a genuine reddish sandstone, or may intercalate some shale-layers rich in fossils. Between these beds and the next, there is always a line of unconformability. The name of the beds was first chosen by Mr. S. Nakamura.[1]

2. *Misawa-Beds.* A loose sand sometimes changing into a conglomerate. This is what Mr. Nakamura called *Misawa Sandstone*.[2] Fossiliferous.

3. *Kamenoo-Beds.*[3] Tufaceous shale, thinly cleavable. Sometimes it is replaced by alternations of white tuffite, sandstone and shale. Fossiliferous. Mr. Nakamura called these beds *Kamenoo Shale*.

4. *Mizunoya-Beds.*[4] Either a shale with loose sandstone layers or a sandstone with shale-layers. If both are found in the same place, the former is usually found in the lower part. Fossiliferous. The name of the beds was first given by Mr. Nakamura. Occasionally wanting.

5. *Goyasu-Beds.*[5] A rather hard shaly sandstone with either conglomerate or common sandstone in the lower part. Within the beds there is one or two seams of coal of inferior quality. Fossiliferous. This is the *Goyasu Sandstone* of Mr. Nakamura.

6. *Shirasaka-Beds.*[6] This is what Mr. Nakamura called *Shirasaka Shale*, a thin tufaceous shale barren of fossils and gradually passing into the next one.

7. *Asagai-Beds.*[7] This is the *Asagai Sandstone* of Mr. Nakamura, a sandstone not very thick, but containing numerous fossils.

8. *Iwaki-Beds.*[8] The upper part is a hard fine-grained sandstone containing either conglomerate or shale layers. This is the *Iwaki Sandstone* of Mr. Nakamura. The lower part is also a hard sandstone occasionally containing thin layers of shale. This is the *Coal-Bearing Series* of Mr. Nakamura, the principal seams of coal being found in this part, and indeed within 30 metres from the bottom where there is a conglomerate made up of the pebbles of older rocks. Fossiliferous. The fossils are either plants or animals (mostly Mollusca).

The fossils which are described in the following pages are those of the Mollusca collected by Dr. Tokunaga in the two lowest beds of the coal-field, the *Asagai* and the *Iwaki*, in the course of his investigation of the said field. They are the following:

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1) Mr. Shintaro Nakamura, now professor of geology in the Imperial University of Kyoto, studied these layers, while he was in the Imperial Geological Survey.

2) 三澤　3) 龜尾　4) 水谷　5) 五安
6) 白坂　7) 淺貝　8) 石城

	Iwaki	Asagai
1. Chrysodomus phoeniceus Dall		+
2. Nassa sp.		+
3. Ocinebra tsuzurensis n. sp.	+	
4. Turritella tokunagai n. sp.		+
5. Turritella importuna n. sp.		+
6. Turritella sp.	+	
7. Crepidula auricula n. sp.		+
8. Calyptraea mammilaris Brod.		+
9. Natica janthostoma Desh.		+
10. Umbonium sp.		+
11. Mya crassa Grew.		+
12. Macoma praetexta Mart.		+
13. Macoma inquinata Desh.	+	+
14. Tellina alternata Say var. chibana Yok.		+
15. Tellina sejugata n. sp.		+
16. Tellina besshoensis n. sp.		+
17. Dosinia sp.		+
18. Meretrix (Callista) chinensis Chem.	+	
19. Venus furtiva n. sp.		+
20. Venus terrena n. sp.		+
21. Cardium (Laevicardium) jobanicum n. sp.	+	
22. Cardium (Laevicardium) squalidum n. sp.	+	
23. Cardium (Laevicardium) tristiculum n. sp.		+
24. Cardium shinjiense Yok.	+	+
25. Papyridea (Fulvia) nipponica n. sp.		+
26. Thyasira bisecta Conr.		+
27. Venericardia tokunagai n. sp.		+
28. Venericardia pacifera n. sp.		+
29. Venericardia laxata n. sp.		+
30. Venericardia sp.	+	
31. Mytilus luciferus n. sp.	+	
32. Mytilus takiensis n. sp.	+	
33. Modiola modiolus L.	+	
34. Lima yumotoensis n. sp.		+
35. Ostrea cf. gigas Thumb.	+	
36. Ostrea mundana n. sp.	+	
37. Ostrea takiana n. sp.	+	

	Iwaki	Asagai
38. Pectunculus vestitus Dkr.	+	
39. Nucula insignis Adams.		+
40. Nucula sp.		+
41. Leda yabei n. sp.		+
42. Yoldia laudabilis n. sp.		+

The localities in which the above fossils were collected number thirty-five in all, of which seven are undoubtedly in the Iwaki-Beds and twenty-four in the Asagai-Beds. The remaining four are somewhat doubtful in their position, but provisionally two (outside of the Nakoso Coal-Mine and Tenjinmae, Kamidaki) have been assigned to the former and two (Tatsuta Coal-Mine and Hannukizawa) to the latter. The thirty-five localities with their respective fossil contents are as follows :

A. Iwaki-Beds.

I. Iwaki Coal-Mine, Tsuzura.[1]

1. Ocinebra tsuzurensis n. sp.
2. Ostrea cf. gigas Thunb.

II. Dōdaira Misawa.[2]

1. Meretrix (Callista) chinensis Chem.
2. Cardium squalidum n. sp.
3. Venericardia sp.
4. Modiola modiolus Linné.

III. Taki Coal-Mine.[3]

1. Mytilus takiensis n. sp.
2. Ostrea takiana n. sp.

IV. Takinakayama.[4]

1. Modiola modiolus Linné.
2. Pectunculus vestitus Dkr.

V. Taki Road (river-side).[5]

1. Cardium jobanicum n. sp.

1) 磐城國石城郡內鄉村綴、磐城炭礦東斜坑　2) 同郡窪田村三澤堂平
3) 同郡上遠野村瀧坑內　4) 同郡上遠野村瀧中山　5) 同郡上遠野瀧道路川側

VI. Araya Coal-Mine (Outside).[1]

1. Mytilus luciferus n. sp.

VII. Iriyama Coal-Mine (Inside).[2]

1. Macoma inquinata Desh.

VIII. Nakoso Coal-Mine (Outside).[3]

1. Turritella sp.
2. Ostrea mundana n. sp.

IX. Tenjinmae, Kamidaki.[4]

1. Turritella sp.
2. Cardium jobanicum n. sp.

B. Asagai-Beds.

X. Dainoyama, Yumoto.[5]

1. Chrysodomus phoeniceus Dall.
2. Natica janthostoma Desh.
3. Mya crassa Grew.
4. Cardium shinjiense Yok.
5. Papyridea (Fulvia) nipponica n. sp.
6. Lima yumotoensis n. sp.
7. Nucula sp.

XI. Bessho, Iwasaki.[6]

1. Turritella tokunagai n. sp.
2. Tellina sejugata n. sp.
3. Tellina besshoensis n. sp.
4. Cardium shinjiense Yok.
5. Venericardia pacifera n. sp.

XII. Iriyama Fifth Coal-Mine.[7]

1. Macoma inquinata Desh.
2. Cardium shinjiense Yok.

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1) 同郡山田村大谷新谷坑外
2) 同郡湯本町入山炭礦坑内
3) 同郡窪田村勿來炭坑社宅前
4) 同郡上遠野村上濕天神前
5) 同郡湯本町臺ノ山
6) 同郡磐崎村別所
7) 同郡湯本町入山五坑竪坑

XIII. Okegasaku, Tsuzura.[1]

1. Mya crassa Grew.

XIV. Sakurai, Tsuzura.[2]

1. Turritella importuna n. sp. ?

XV. Akiyama, Uchigō.[3]

1. Calyptraea mammilaris Brod.
2. Mya crassa Grew.
3. Venus furtiva n. sp.
4. Venericardia laxata n. sp.

XVI. Wariyama, Akai.[4]

1. Natica janthostoma Desh.
2. Tellina alternata Say, var. chibana Yok.
3. Venericardia pacifera n. sp.

XVII. Yotsukura Coast.[5]

1. Turritella importuna n. sp.
2. Mya crassa Grew.
3. Cardium shinjiense Yok.
4. Venericardia laxata n. sp.

XVIII. Shimosaka, Nakashima.[6]

1. Mya crassa Grew.
2. Cardium shinjiense Yok.
3. Yoldia laudabilis n. sp.

XIX. Hannukizawa, Yoshima.[7]

1. Chrysodomus phoeniceus Dall.
2. Venericardia pacifera n. sp.
3. Nucula insignis Ad.

XX. Tanoami, Hisanohama.[8]

1. Turritella tokunagai n. sp.
2. Macoma praetexta n. sp.
3. Venericardia laxata n. sp.

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1) 磐城國石城郡內鄉村綴オケガ作堤側　2) 同郡內鄉村綴櫻井　3) 內鄉村秋山
4) 同郡赤井村赤井割山　5) 石城郡四倉町海岸　6) 同郡大野村中嶋下坂
7) 同郡好間村半貫澤　8) 双葉郡久之濱町田之網

XXI. Tengasawa, Oyamada.[1]

1. Mya crassa Grew.
2. Venus terrena n. sp.
3. Cardium shinjiense Yok.
4. Papyridea (Fulvia) nipponica n. sp.
5. Leda yabei n. sp.

XXII. Kami-Kitaba, Hirono.[2]

1. Cardium shinjiense Yok.

XXIII. Hirono, west of a railway-tunnel of East Japan Coal Mining Co.[3]

1. Mya crassa Grew.
2. Venus terrena n. sp.
3. Venericardia tokunagai n. sp.
4. Venericardia laxata n. sp.

XXIV. Between Osaka and the Fifth Mine of Hirono.[4]

1. Mya crassa Grew.
2. Papyridea (Fulvia) nipponica n. sp.
3. Venericardia laxata n. sp.

XXV. Ōbisa.[5]

1. Chrysodomus phoeniceus Dall.
2. Turritella tokunagai n. sp. ?
3. Crepidula auricula n. sp.
4. Mya crassa Grew.
5. Dosinia sp.
6. Papyridea (Fulvia) nipponica n. sp.
7. Venericardia tokunagai n. sp.
8. Nucula insignis Ad.

XXVI. Shinyashiki, Ōbisa.[6]

1. Mya crassa Grew.
2. Cardium shinjiense Yok.

XXVII. Kobisa.[7]

1. Crepidula auricula n. sp.

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1) 双葉郡大久村小山田天ケ澤
2) 同郡廣野村上北迫
3) 同郡廣野村東日本炭礦鐵道トンネル西
4) 大坂、廣野炭礦五坑間
5) 大久村大久
6) 大久村新屋敷
7) 大久村小久

2. Mya crassa Grew,
3. Venus furtiva n. sp.
4. Venericardia laxata n. sp.

XXVIII. Shinyashiki, Suetsugu.[1]

1. Turritella tokunagai n. sp.
2. Yoldia laudabilis n. sp.

XXIX. Numanosaku, Ōno.[2]

1. Mya crassa Grew.
2. Cardium tristiculum n. sp.
3. Papyridea (Fulvia) nipponica n. sp.

XXX. Yamadaoka Coal-Mine, Hirono.[3]

1. Mya crassa Grew.
2. Macoma inquinata Desh.
3. Cardium tristiculum n. sp.
4. Cardium shinjiense Yok.
5. Venericardia pacifera n. sp.
6. Venericardia laxata n. sp.

XXXI. Near Yamadaoka, Hirono.[4]

1. Venericardia laxata n. sp.

XXXII. Between Yamadaoka and Nabezuka.[5]

1. Macoma inquinata Desh.
2. Venericardia laxata n. sp.
3. Nucula insignis Ad.

XXXIII. Tatsuta Coal Mine (Entrance-side).[6]

1. Mya crassa Grew.
2. Papyridea (Fulvia) nipponica n. sp.
3. Venericardia laxata n. sp.
4. Leda yabei n. sp.

XXXIV. Tatsuta Coal-Mine.[7]

1. Nassa sp.
2. Turritella importuna n. sp. ?

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1) 同郡久之濱町末續新屋敷川ノ中　2) 双葉郡大野村沼ノ作
3) 同　郡廣野村山田崗炭坑　4) 山田崗附近
5) 山田崗、鍋塚間　6) 同郡龍田村龍田炭坑口側　7) 龍田炭坑

3. Natica janthostoma Desh.
4. Umbonium sp.
5. Yoldia laudabilis n. sp. ?

XXXV. Futaba Coal-Mine.[1]

1. Papyridea (Fulvia) nipponica n. sp.
2. Venericardia laxata n. sp.

As seen from the foregoing table, the number of the fossil forms obtained in the above localities amounts in all to 42, of which 6, however, are not yet exactly determined. The remaining 36, though far from being called sufficient, nevertheless gives a fairly good idea about the nature of the Molluscan fauna found in the lowest horizons of the coal-field. Thus, out of these 36, only 10 are living, the rest, so far as our present investigation goes, being extinct. This makes the proportion of these two forms of fossils 1 to 2.6, or in other words, the extinct are about two and a half times as many as the living. From this so much is certain that the number of extinct forms far exceeds one-half of the entire fauna, being about 70% of it. From these considerations, I deem the geological age of the *Iwaki-* as well as the *Asagai-Beds* as *Miocene*.

It is a remarkable fact that these two groups of beds show such a small relationship to each other in their faunistic characters. Out of the twenty-one extinct forms described from them, only one is common to both, that is *Cardium shinjiense*. I do not doubt that this is merely accidental. When more fossils are obtained, there will certainly be several others which go from one group to the other, because their geological position is so close.

Description of the Species.

1. **Chrysodomus phoeniceus,** Dall.

Chrysodomus phoeniceus. Yokoyama, Foss. Miura Penin., p. 50, pl. II, figs. 8–10.

Several specimens adult as well as young, though mostly in the form of casts. This species lives in British Columbia.

Occurrence.—*Asagai-Beds:* Dainoyama; Ōbisa; Hannukizawa.

2. **Nassa** sp.

Pl. I. Fig. 4.

A badly preserved specimen with the greater part of the spire lacking. The shell-matter was mostly destroyed in trying to free it from the stone,

1) 双葉郡木戸村双葉炭坑

so that it is now in the form of a semi-cast. Nevertheless, the somewhat shouldered body-whorl with the traces of longitudinal striations makes the shell appear like *Nassa livescens* Phil. (Yokoyama, Foss. Miura Penin., p. 58, pl. III, fig. 18), although a strict comparison is at present impossible.

Occurrence.—*Asagai-Beds:* The Tatsuta Coal-Mine.

3. **Ocinebra tsuzurensis,** n. sp.

Pl. I. Figs. 1, 2, 3.

There are several specimens more or less broken or deformed, but characteristic enough to be created into a new species.

The shell is more or less pyriform, with whorls convex and rapidly growing, so that the last one is very large. It is longitudinally plicated, with plicae about twelve on the body-whorl and most distinct a little below the suture, thinning out on the base and finally disappearing towards its end. The spiral cords are also present all over the body-whorl, and are close and numerous. Fig. 2 represents an example pressed down from the apical side, making the body-whorl much shorter than it really is.

Occurrence.—*Iwaki-Beds:* In an eastward inclined shaft of the Tsuzura Coal-Mine.

4. **Turritella tokunagai,** n. sp.

Pl. I. Figs. 8, 9, 10.

The shell is medium-sized and many-whorled. The whorls number a little over ten in number, are convex and spirally ridged. The ridges are five in number, of which the uppermost and the lowest are situated close to their respective sutures. Of the three remaining ridges, the middle is the strongest and found where the convexity of the whorls is greatest. These ridges are in some specimens sharp and much narrower than their interstices, while in the others more flattened and broader, a character probably due to weathering. The apical angle is about 20°. Not rare.

It is much to be regretted that none of the specimens is perfectly preserved.

Occurrence.—*Asagai-Beds:* Tanoami in Hisanohama; Bessho; Shinyashiki, Suetsugu; Obisa (a doubtful specimen).

5. **Turritella importuna,** n. sp.

Pl. I. Figs. 6, 7.

Shell medium-sized, many-whorled, with whorls convex and spirally four-corded. Cords broad and flat, broader than interspaces, with the lowest strongest. Besides these four main cords, there is a small one close

to the lower suture. On the body-whorl, there is a narrow groove below the lowest cord. Base flattish, with a few indistinct flat cords. Apical angle about 25°.

This species looks like the preceding, and when the preservation is imperfect, it is difficult to distinguish it from the former. But it is preeminently four-corded, with the apical angle greater.

The two examples shown in the figures, though apparently somewhat different in shape, probably belong to the same species, the difference being due to deformation in both.

Occurrence.—*Asagai-Beds:* Yotsukura Coast. A doubtful specimen was found at Sakurai in Tsuzura and another in the Tatsuta Coal-Mine (both *Asagai*).

6. **Turritella** sp.

A mutilated specimen with the apical portion lacking, but still with more than ten whorls preserved. The external sculpture is unknown. The aperture seems to have been oval, though only partly preserved. It does not exactly agree with the two preceding forms. Height 30 millim. Diameter about 9 millim.

Occurrence.—*Iwaki-Beds:* Kamidaki, Tenjinmae. A similar undeterminable shell was also found in the Nakoso Coal-Mine (probably Iwaki).

7. **Crepidula auricula,** n. sp.

Pl. I. Fig. 5.

Shell small, smooth, narrowly oblong in outline, strongly convex, almost twice as long as broad. Beak spirally coiled, *Haliotis*-like, small. Taking the length as 10, the breadth is 5 and the convexity 7. The largest specimen measures 30 millim. in length.

A remarkably convex form, somewhat reminding of *Crepidula incurva* Zittel (Palaeont. Neusulands, p. 44, pl. XV, fig. 9) from the Pliocene of New Zealand, though the convexity is still greater and the apex more spiral. Rare.

Occurrence.—*Asagai-Beds:* Obisa; Kobisa.

8. **Calyptraea** mammilaris, (Brod).

Pl. I. Fig. 17.

Calyptraea mammilaris. Yokoyama, Foss. Miura Penin., p. 75, pl. IV, fig 5. Foss. Up. Musashino, p. 82.

A comparatively large example, conical in shape and roundly elliptical in outline. The whorls are more or less convex, though the last one is flat.

Diameter about 23 millim. Height about 10 millim. The shell-matter has been to a greater part dostroyed, but the surface seems to have been smooth.

Occurrence.—*Asagai-Beds:* Akiyama.

9. **Natica janthostoma,** Desh.

Pl. I. Fig. 20.

Natica janthostoma. Yokoyama, Foss. Miura, Penin., p. 77, pl. V, figs. 3, 4. Foss. Up. Musash., p. 83. Foss. Moll. Izumo, p. 4. Tert. Moll. Dainichi, p. 12. Tert. Foss. Kii, p. 53.

Good specimens are rare.

Occurrence.—*Asagai-Beds:* The Tatsuta Coal-Mine; Dainoyama, Yumoto; Wariyama, Akai.

10. **Umbonium,** sp.

Pl. I. Figs. 18, 19.

Two decorticated specimens of a comparatively high-conical shell, much higher than the species of the same genus already found in the Tertiary of Dainichi such as *Umbonium suchiense* Yok. and *U. mysticum* Yok. (Tert. Foss. Dainichi, p. 13, pl. II). The surface of the whorls which are also more convex seems to have been smooth. The apical angle is almost a right angle.

Occurrence.—*Asagai-Beds:* The Tatsuta Coal-Mine.

11. **Mya crassa,** Grew.

Pl. I. Figs. 11-16.

Mya crassa. Grewinck, Beitr. z. Kenntn. d. NW. Küste Amerikas m.d. anlieg. Inseln, p. 282, pl. VI, figs. 2a-2d. Dall in Geol. a. Palaeont., Harriman Alaska Exped., a. 117.

The presence of this species in Japan was first recognized by the late Prof. K. Jimbo who had an opportunity to compare the specimens collected by him in the Hokkaido with those from Alaska during his sojourn in Petrograd many years ago. Since then, it is mentioned as such by Prof. Yabe in his "Recent Stratigraphical and Palaeontological Studies of the Japanese Tertiary," while Dr. Makiyama gave an accurate description of it in the Journal of the Geological Society of Japan (vol. 28, 1921) from his study on the specimens found in the Jôban Coal-field.

The form of the shell is rather variable; but it may be defined as transversely suboval inclining to triangular, with the sharper end directed baekward. It is slightly inequilateral with the anterior side shorter, swollen in front and compressed behind. The surface is smooth, only with rude lines of growth. In the specimens we possess, the proportion of length to height and thickness on an average may be something like 10 to

6.2 and 4.5. This makes them longer than the Alaska form which Eichwald describes as "nearly circular" (Geognost. palaeont. Bemerk. über Mangischlak, p. 124).

Occurrence.—*Asagai-Beds*. The following are the localities: 1. Yotsukura sea-coast; 2. Tengasawa, Oyamada; 3. Between Osaka and the Fifth Coal-mine of Hirono; 4. Shinyashiki, Ōbisa; 5. Yamadaoka; 6. Ōbisa; 7. Numanosaku; 8. Kobisa; 9. Hirono, west of a railway tunnel of the East Japan Coal-Mining Co.; 10. The entrance-side of the Tatsuta Coal-Mine; 11. Dainoyama, Yumoto; 12. Okegasaku, Tsuzura; 13. Shimosaka, Nakashima.

Outside of Japan, this species occurs in the so-called Miocene of Alaska and of the west coast of America,[1] as well as in the Tertiary of Russian Sakhalin.

12. **Macoma praetexta**, (Mart.).

Macoma praetexta. Yokoyama, Foss. Up. Musash., p. 142, pl. X, figs. 2, 3. Tert. Foss. Dainichi, p. 15.

A single example with both valves perfect, though somewhat crushed.

Occurrence.—*Asagai-Beds:* Tanoami, Hisanohama.

13. **Macoma inquinata**, (Desh.).

Macoma inquinata. Yokoyama, Foss. Miura Penin., p. 117, pl. VIII, figs. 1, 2, Foss. Up. Musashino., p. 142. Tert. Foss. Kii, p. 56.

Mostly young individuals, though an adult one was found at Bessho. Very frequent at some localities as at Yamadaoka.

Occurrence.—*Iwaki-Beds:* The fifth coal-mine of Iriyama. *Asagai-Beds:* 1. Yamadaoka; 2. a place between Yamadaoka and Nabezuka; 3. Bessho; 4. The coal-mine of Iriyama.

14. **Tellina alternata**, Say **var. chibana**, Yok.

Pl. II. Fig. 20.

Tellina alternata var. chibana. Yokoyama, Foss. Up. Musash., p. 140, pl. X, figs. 5, 6.

A right valve, quite agreeing with that of the cited variety from the Upper Musashino Formation. It is 37 millim. long and 20 millim. high. The thickness can not be measured, as the specimen is pressed quite flat.

Occurrence.—*Asagai-Beds:* Wariyama, Akai.

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1) Prof. Yabe is of opinion that a fossil from Sakhalin described as *Pleuromya cuneiformis* and taken for cretaceous by Böhm (Ueb. Kreideverstein. v. Sakhalin, Jahrb. Preuss. Geol. Landesanst., XXXVI, pt. I, fasc. 3) is nothing else than *Mya crassa* of the Tertiary, as he was convinced by inspecting the original specimen of Böhm in Hamburg.

15. **Tellina sejugata,** n. sp.

Pl. II. Figs. 9, 10, 11.

Shell transversely oblong, compressed, slightly inequilateral, with anterior side longer than posterior; anterior border rounded, posterior subtruncate, ventral broadly arcuate, antero-dorsal as well as postero-dorsal nearly straight, only very little sloping, the former less so than the latter. Posterior flexure weak. Surface smooth. Beaks very small.

A single specimen with both valves perfect. It is 35 millim. long, 24 millim. high and 10 millim. thick.

Occurrence.—*Asagai-Beds:* Bessho.

16. **Tellina besshoensis,** n. sp.

Pl. II. Figs. 1-5.

Shell large, transversely oval, inequivalve, subequilateral, somewhat rostrate behind. Both valves convex in the middle, the left much less so than the right, compressed near the posterior end. Anterior and posterior borders rounded, with the latter more sharply, antero-dorsal straight or even somewhat excavated, postero-dorsal nearly straight. Surface smooth, only with rude lines of growth. Length 74 millim. Height 55 millim. Thickness 22 millim.

Occurrence.—*Asagai-Beds:* Bessho; doubtful fragments at Okegasaku, Tsuzura.

17. **Dosinia** sp.

An imperfect specimen, 47 millim. high, about 50 millim. long and 28 millim. thick. It is to a greater part deprived of its shell and indeterminable, though not unlike *Dosinia troscheli* Lke. in which, however, the sinus is deeper.

Occurrence.—*Asagai-Beds:* Ōbisa.

18. **Meretrix (Callista) chinensis,** (Chem.).

Pl. II. Figs. 7, 8.

Meretrix (Callista) chinensis. Yokoyama, Foss. Miura, Penin., p. 120, pl. VIII, figs. 9, 10. Foss. Up. Musashino, p. 146, pl. XI, fig. 5.

Pretty frequent. The fossil specimens are a little more bluntly rounded behind than most of the living ones, although such are occasionally found also among the latter.

Occurrence.—*Iwaki-Beds:* Dōdaira.

19. **Venus furtiva,** n. sp.

Pl. II. Fig. 6.

Shell small, ovately trigonal, convex, inequilateral, anterior side shorter than posterior, rounded at both ends, though more sharply behind than in front; ventral border broadly arched, antero- and postero-dorsal straight, sloping, making with each other an angle a little greater than a right angle. Surface concentrically grooved. Beaks small, pointed. Pallial sinus moderate in depth, obliquely ascending and quickly narrowing with end rounded; the depth is nearly equal to the width of the mouth.

Two examples. The one measures 16 millim. in length, 11 millim. in height and 6 millim. in thickness; while the other measures 18 millim. in length, 13 millim. in height and 7 millim. in thickness.

Occurrence.—*Asagai-Beds:* Kobisa.

20. **Venus terrena,** n. sp.

Pl. II. Fig. 19.

Shell small, transverse, longly ovate, convex, very inequilateral, rounded in front and behind though rather sharply behind; antero- and postero-dorsal borders making with each other a very obtuse angle (about 135°), ventral very broadly arched. Beaks small, not very prominent. Surface only with rude incremental lines. Pallial sinus short, triangular, blunt at end.

This species is somewhat like the preceding, but comparatively longer, the proportion of length to height being about 10 to 6 or a little more, while the thickness is equal to about 4. The largest example is 23 millim. long. Most of the specimens are deprived of their shell, though they are found pretty frequently.

Occurrence.—*Asagai-Beds:* Hirono, at a place west of a railway tunnel of the East Japan Coal-Mining Co.; Tengasawa, Oyamada.

21. **Cardium (Laevicardium) jobanicum,** n. sp.

Pl. II. Figs. 12–18.

Shell moderately thick, suborbicular, inflated, subequilateral. Antero-dorsal border more or less straight, sloping; postero-dorsal arched. Surface with numerous, close, straight, radiating striae. Incremental lines distinct. Inner border finely crenulate. Beaks small, but prominent, incurved and pointed.

Pretty frequent. The largest example is 32 millim. long, 30 millim.

high and 18 millim. thick. Another, somewhat smaller one is 22 millim. long, 20 millim. high and 13 millim. thick.

Occurrence.—*Iwaki-Beds:* A river-side below the Taki Road; Tenjin-mae, Kamidaki.

22. **Cardium (Laevicardium) squalidum,** n. sp.

Pl. III. Fig. 1.

Shell moderate in size and thickness, convex, suborbicular, somewhat longer than high, inequilateral; anterior border more bluntly rounded than posterior. Surface smooth, though with rude lines of growth. Beaks somewhat swollen, prominent. The right valve shown in the figure is 50 millim. long, 47 millim. high and 12 millim. deep. Very rare.

This shell looks somewhat like *Cardium pauperculum* Yok. (Foss. Moll. Neog. Izumo, p. 6, pl. I, fig. 2) which, however, is higher and more inflated.

Occurrence.—*Iwaki-Beds:* Dōdaira.

23. **Cardium (Laevicardium) tristiculum,** n. sp.

Pl. III. Figs. 5, 6, 7.

Shell somewhat smaller than the preceding, rather thin, only moderately inflated, suborbicular, a little longer than high, subequilateral. Surface with a very blunt edge running from beak to postero-ventral corner, and ornamented with close, fine, straight, radiating riblets or striae whose number may be up to 60. Beaks more or less inflated.

A right valve shown in fig. 7 is 37 millim. long, 31 millim. high and 7 millim. deep. Figs. 5 and 6 are somewhat deformed specimens.

This species resembles *Cardium muticum* Rve. (Yokoyama, Foss. Miura Penin., pl. IX, fig. 11) without any perfect identity.

Occurrence.—*Asagai-Beds:* Numanosaku, Yamadaoka.

24. **Cardium shinjiense,** Yok.

Pl. III. Figs. 13, 14, 15.

Cardium shinjiense. Yokoyama, Some Foss. Moll. fr. Neog. Izumo (Jap. Jour. Geol. Geogr., Vol. II, No. 7) pl. II, fig. 6.

The shell is medium-sized, rather thin, moderately convex and suborbicular to roundly ovate in outline, sometimes with an obtuse flattish edge running from the beak to the postero-ventral corner, a character which may possibly be due to pressure. The radiating ribs are about 36 in number, elevated and flattish, separated by intervals of about equal breadth. The largest example we possess is 29 millim. both in length and height.

The specimens, when compared with those of the Pliocene of Izumo, are generally somewhat flatter, being about $\frac{3}{5}$ of the length. But as deformation is great in nearly all the fossils of our coal-field, the above mentioned difference may have arisen from pressure.

Whether this species is not the same as *Cardium decoratum* Grew. (Beitr. NW. Am., p. 274, pl. IV, figs. 3a–3g) as supposed by some, I am now not in a position to decide, although the resemblance seems to be very great.

Occurrence.—*Iwaki-Beds:* The fifth coal-mine of Iriyama. *Asagai-Beds:* 1. Yamadaoka ; 2. Tengasawa, Oyamada ; 3. Shinyashiki, Obisa ; 4. Dainoyama, Yumoto ; 5 Bessho ; 6. Shimosaka, Nakashima ; 7. Kami-Kitaba ; 8. Akiyama ; 9. The upper course of the Okegasakusawa, Tsuzura ; 10. Yotsukura Coast.

25. **Papyridea (Fulvia) nipponica,** n. sp,

Pl. III. Figs. 3, 4.

Shell large, rather compressed, transversely oval, nearly equilateral, rounded at both ends, though more sharply in front than behind, broadly arched at ventre. Surface radiately ribbed ; ribs about 50 in number, close, straight or sometimes slightly curved backward, flatly rounded, generally broader than interspaces, coarsest in the posterior part.

Although frequent, most of the specimens are deformed or broken. Fig. 4 is a young specimen much magnified. It gives the general outline of the shell most correctly. Taking the length as 10, the height is 7.7 and the thickness 4. The largest specimen attains the length of more than 650 millim.

This species shows a great resemblance to *Papyridea bullatum* Chem. (Syst. Conch. Cab., Cardium, p. 75, pl. 12, figs. 13-16) living in the West Indies. But our fossil grows larger, is more equilateral, with beaks more swollen, and the posterior end not spiny as in the living form.

Another species which is close to this is *Papyridea harrimani* Dall (Geol. a. Polaeont., Harriman's Alaska Expedition, p. 114, pl. x, fig. 15) from the Miocene of Alaska which is, however, shorter and possesses a less number of ribs (said to be 35).

Occurrence.—*Asagai-Beds:* 1. Numanosaku ; 2. The entrance-side of the Tatsuta Coal-Mine ; 3. The Futaba Coal-Mine, Kido ; 4. Tengasawa, Oyamada ; 5. Obisa ; 6. Between Osaka and the Fifth Coal-Mine of Hirono ; 7. Dainoyama, Yumoto.

26. **Thyasira bisecta,** (Conrad).

Pl. III. Fig. 2.

Thyasira bisecta. Arnold, Stratigr. a. Palaeont. San Pedro, Calif., p. 135, pl. XV, fig. 5.
Venus bisecta. Conrad, Geol. U. S. Explor. Exped., p. 724, pl. 17, fig. 10.
Conchocele disjuncta. Gabb, Pal. Cal., III, p. 27, pl. 7, fig. 48.

This species now living in the North Pacific and Puget Sound is not only found in the Miocene and Pliocene of the Pacific coast of North America, but also widely spread in the Neogene of Japan.

From the Jô-Ban Coal-field, only a few casts were obtained.

Occurrence.—*Asagai-Beds:* The upper course of the Okegasakusawa, Tsuzura.

27. **Venericardia tokunagai,** n. sp.

Pl. III. Figs. 10, 11.

Shell moderate in size, thick, compressed, obliquely trigonal, somewhat longer than high, rounded at both ends, though much more sharply behind than in front; antero- and postero-dorsal borders sloping, making with each other an angle a little greater than a right angle; ventral border broadly arched. Surface radiately ribbed; ribs a little over 25 in number, more or less straight, closer behind than in front, flattened, with about equal interspaces. Beaks prominent, more or less bluntly pointed.

A few specimens. The figured one measures 40 millim, in length, 36 millim in height and 20 millim in thickness. Another somewhat smaller and deformed one measures 34 millim in length, 33 millim in height and 16 millim in thickness.

Occurrence.—*Asagai-Beds:* Obisa; a place in Hirono, west of a railway tunnel of the East-Japan Coal-Mining Co.

28. **Venericardia pacifera,** n. sp.

Pl. IV. Figs 1, 2.

Shell medium-sized, thick, rather compressed, ovately trigonal, very inequilateral, rounded in front, subtruncate behind; antero-dorsal border more or less straight, short, postero-dorsal somewhat arched, longer, both sloping and making with each other a very obtuse angle; ventral border broadly arched. Surface radiately ribbed, with ribs about 20 in number, broad, flat, separated by valleys of nearly equal breadth, on the hinder part occasionally splitting into two by a longitudinal groove. Lunula heart-shaped.

The largest perfect example is 40 millim. long, 36 millim. high and 20 millim. thick. Among the imperfect ones, there is a still larger. Young individuals are generally more rounded than adult ones.

Occurrance.—*Asagai-Beds:* Yamadaoka; Hannukisawa, Yoshima; Wariyama, Akai.

29. **Venericardia laxata**, n, sp.

Pl. III. Figs. 16, 17, 18.

Shell smaller than the preceding, thick, rather compressed, very broadly ovate, somewhat inequilateral, almost equally rounded both in front and behind. Surface radiately ribbed, with ribs 20 to 25 in number, broad, flattish, closer behind than in front, separated by intervals of equal or narrower breadth. Beaks small, though pointed. Length, height and thickness are on an average in the ratio of 10 : 8,2 : 4,2. The largest example is about 27 millim. long.

Occurrance.—*Asagai-Beds:* 1. Yamadaoka; 2. The Futaba Coal-Mine, Kido; 3. Hirono, west of a railway-tunnel of the East-Japan Coal-Mining Co.; 4. The Yotsukura sea-coast; 5. The entrance-side of the Tatsuta Coal-Mine; 6. Kobisa; 7. Tanoami; 8. Between Yamadaoka and Nabezuka; 9. Between Osaka and the Fifth Mine of Hirono; 10. Near Yamadaoka Coal-Mine.

30. **Venericardia**, sp.

Pl. III. Figs. 8, 9.

Shell medium-sized, thick, obliquely ovate, rather convex, very inequilateral, anteriorly rounded, posteriorly truncate, ventrally broadly arched, postero-ventral corner rounded. Surface with a very blunt indistinct edge running from beak to postero-ventral corner; radiately ribbed, with ribs about 24 in number, slightly curved forward in front of dorsal edge, more or less straight behind, flatly rounded, separated by equal or somewhat narrower interspaces flattened at bottom. Beaks prominent, more or less pointed. Main teeth two; posterior lateral single, long.

A right and a left valve belonging to different individuals. Both are about 30 millim. in height as well as in length, and about 10 millim. in depth.

For the present, I leave this species unnamed, because it is extremely like a particularly large form of *Venericardia ferruginea* Ad. (Yokoyama, Foss, Miura Penin., pl. XI, Figs. 3, 4) frequently found in the uppermost beds of the coal-field, the fossil content of which I intend soon to describe.

Occurrance.—*Iwaki-Beds:* Dōdaira.

31. **Mytilus luciferus**, n. sp.

Pl. IV. Figs. 4.

Shell large, moderately inflated, elongated, length a little less than one-half of height, almost straight in front, also straight or slightly

arched behind, going over on one hand into more arched postero-dorsal border, on the other into rounded ventral. Surface smooth.

The shell-substance has been to a greater part destroyed.

This species has some distant resemblance to *Mytilus hesperus* Lam. (Wood, Crag Moll., Bivalves, p. 53, pl. VIII, fig. 10) and *Mytilus crassitesta* Lke. (Jap. Meeresconch., I, Pl. XI).

Occurrence.—*Iwaki-Beds:* The Araya Coal-Mine, Oya.

32. **Mytilus takiensis**, n. sp.

Pl. IV. Figs. 5, 6.

This shell is also large, but more elongated and swollen, with the anterior border slightly concave, and the posterior more straight, while the ventral is more sharply rounded. The beak is also more pointed.

A single specimen, about 35 millim in length and 103 millim in height.

Occurrence.—*Iwaki-Beds:* The Taki Coal-Mine.

33. **Modiola modiolus**, L.

Pl. IV. Figs. 7, 8.

Modiola modiolus. Yokoyama, Foss. Miura Penin., p. 145, pl. XI, fig. 21. Foss. Up. Musash., p. 175. Foss. Moll. Neog. Izumo, p. 7.

Several specimens of this elongated, subcylindrical shell were obtained, comparatively well preserved.

Occurrence.—*Iwaki-Beds:* Dōdaira ; Takinakayama.

34. **Lima yumotoensis**, n. sp.

Pl. IV. Figs. 3.

A single left valve which, however, is quite characteristic to be created into a new species. It is rather small, obliquely ovate in outline, strongly convex, radiately ribbed, with ribs about 25 in number, more or less straight, rounded, separated by valleys of about equal breadth.

Occurrence.—*Asagai-Beds:* Dainoyama.

35. **Ostrea cf. gigas**, Thunb.

Pl. V. Figs. 1, 2.

Many large specimens of an oval to longly ovate shell which, so far as their outline and inner side are concerned, are not distinguishable from the shorter forms of *Ostrea gigas* Th. (Yokoyama, Foss. Miura Penin., pl. XV) which is recent and Pliocene in Japan. It is, however, much to be

regretted that the outer side is invariably firmly attached to the stone, so that it is impossible to expose it.

Occurrence.—*Iwaki-Beds:* The Iwaki Coal-Mine, Tsuzura.

36. **Ostrea mundana**, n. sp.

Pl. V. Fig. 3 ab.

A single upper valve which is thin, elongato-ovate, nearly flat, radiately finely costellated, with costellae numerous, close, more or less sinuous. Length 30 millim. Height 55 millim.

Occurrence.—*Iwaki-Beds:* In front of a building belonging to the Nakoso Coal-Mining Co., Kubota.

37. **Ostrea takiana**, n. sp.

Pl. V. Fig. 4 ab.

A lower valve, thin, convex, elongated, with the beak strongly curved sidewise and pointed. The surface is furnished with concentric corrugations and several faint radiating ribs, distinct only near the beak. Length 25 millim. Height 50 millim. Besides the above specimen, there are also two internal casts.

It is not impossible that this shell belongs to the same species as the preceding. But as the locality is different, it is not possible to decide the question.

Occurrence.—*Iwaki-Beds:* The Taki Coal-Mine, Kadono.

38. **Pectunculus vestitus**, Dkr.

Pectunculus vestitus. Yokoyama, Foss Miura Penin., p. 167, pl. XVII, figs. 10, 11. Foss. Up. Musash., p. 189, pl. XVI, figs. 1–3. Foss. Shells Saishu, p. 7.

Quite frequent.

Occurrence.—*Iwaki-Beds:* Takinakayama.

39. **Nucula insignis**, A. Ad.

Nucula insignis. Yokoyama, Foss. Miura Penin., p. 179, pl. XIX, figs. 7, 8. Up. Musash., p. 198. Foss. Shells Saishu, p. 7.

Numerous at some places.

Occurrence.—*Asagai Beds:* Between Yamadaoka and Nabezuka; Ōbisa; Akiyama; Hannukizawa.

40. **Nucula sp.**

A larger form than the preceding, flatly pressed and also distorted. The outline is triangular, with the surface covered to a greater part with

concentric lines crossed by some radiating ones near the beak. It seems to be a new form, though too imperfect for determination.

Occurrence.—*Asagai-Beds:* Dainoyama.

41. **Leda yabei**, n. sp.

Pl. IV. Figs. 9? 10,

Shell small, thin, compressed, transversely elongato-ovate, subequilateral with the anterior side a little longer than the posterior, rounded in front, subrostrate and bluntly pointed behind ; antero-dorsal border slightly arched, postero-dorsal straight or shallowly excavate. Surface concentrically furrowed.

The length is about twice the height and the thickness about one-half of the latter. The largest specimen is 24 millim long. Rare.

Occurrence.—*Asagai-Beds:* Tengasawa, Oyamada ; the entrance-side of the Tatsuta Coal-mine.

42. **Yoldia laudabilis**, n. sp.

Pl. IV. Figs. 11, 12.

Shell transversely elongated, shortly lanceolate, compressed, nearly equilateral, with the anterior side slightly shorter than the posterior, rounded in front, subrostrate and obliquely truncate behind, with the postero-dorsal corner pointed ; postero-dorsal border slightly concave, ventral broadly arched and going over gradually into anterior as well as posterior border without making any perceptible angle. Surface smooth, only with concentric lines of growth. Beaks small. Lunula longly lanceolate. Length, height and thickness in the ratio of 10 : 5.3 : 2.6. The specimen figured is about 40 millim long. Rather frequent.

This species is like an elongated form of a shell called *Leda myalis* Couth. in the " Crag Mollusca " of Wood (Biv., pl. X, fig. 17c) which, however, is more narrowed and pointed behind. *Yoldia japonica* (Ad. et Rve) (Voy. Samarang, p. 75, XXI, fig. 9) and *Yoldia lischkei* Smith (Challenger Lamellibranchiata, p. 24 2, pl. XX. fig. 4) of our seas are also allied species.

Occurrence.—*Asagai-Beds:* Shinyashiki, Suetsugu ; Shimosaka, Nakashima. A doubtful specimen occurs also in the Tatsuta Coal-Mine.

M. YOKOYAMA.

Molluscan Remains from the Lowest Part of the Jô-Ban Coal-Field.

PLATE I.

Plate I.

Figs. 1, 2, 3. Ocinebra tsuzurensis, n. sp. Iwaki Coal-Mine, Tsuzura. P. 10.

Figs. 4. Nassa sp. Tatsuta Coal-Mine, Tatsuta-mura. P. 9.

Figs. 5. Crepidula auricula n. sp. a. Apertural view. b. Front-view. c. Dorsal view. Kobisa. P. 11.

Figs. 6, 7. Turritella importuna, n. sp. Yotsukura Coast. P. 10.

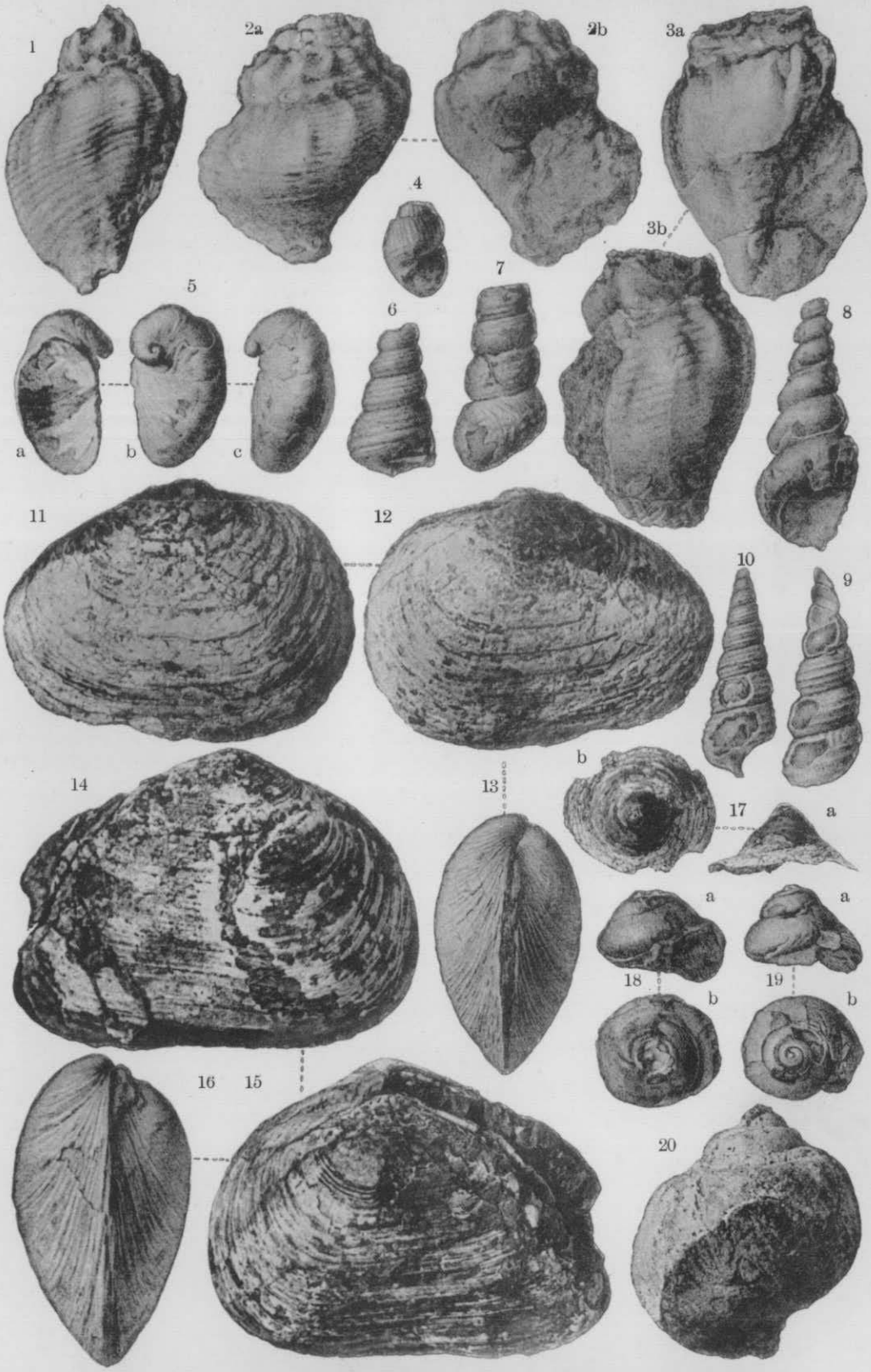
Figs. 8, 9, 10. Turritella tokunagai, n. sp. Tanoami. P. 10.

Figs. 11-16. Mya crassa, Grew. 11, 14. Right valves. 12, 15. Left valves. 13, 16. Front-views. Yotsukura coast. P. 12.

Figs. 17. Calyptraea mammilaris Brod. a. Lateral view. b. Apical view. Akiyama. P. 11.

Figs. 18, 19. Umbonium sp. a. Views from apertural side. b. Views from apex. Tatsuta Coal-Mine, Tatsuta. P. 12.

Figs. 20. Natica janthostoma Desh. Tatsuta Coal-Mine, Tatsuta. P. 12.



M. Yokoyama: Molluscan Remains from the Jô-Ban Coal-Field.

PLATE II.

Plate II.

Figs. 1—5. Tellina besshoensis n. sp. 1,5. Left valves. 2,4. Right valves. 3. View from beak-side. Bessho. P. 14.

Figs. 6. Venus furtiva n. sp. View from left side. a. View from beak-side. Kobisa. P. 15.

Figs. 7, 8. Meretrix (Callista) chinensis Chem. Right valves. Dōdaira P. 14.

Figs. 9—11. Tellina sejugata n. sp. 9. Left valve. 10. View from front. 11. Right valve. Bessho. P. 14.

Figs. 12—18. Cardium (Laevicardium) jōbanicum n. sp. 12, 13, 18. Left valves. 14, 17. Right valves. 15. View from beak-side. 16. The same view, but the valves are somewhat opening at ventre. Tenjinmae, Kamidaki. P. 15.

Figs. 19. Venus terrena n. sp. Left valve. a. shows depth. Tengasawa, Oyamada. P. 15.

Figs. 20. Tellina alternata Say var. chibana Yok. Left valve. Wariyama, Akai. P. 13.

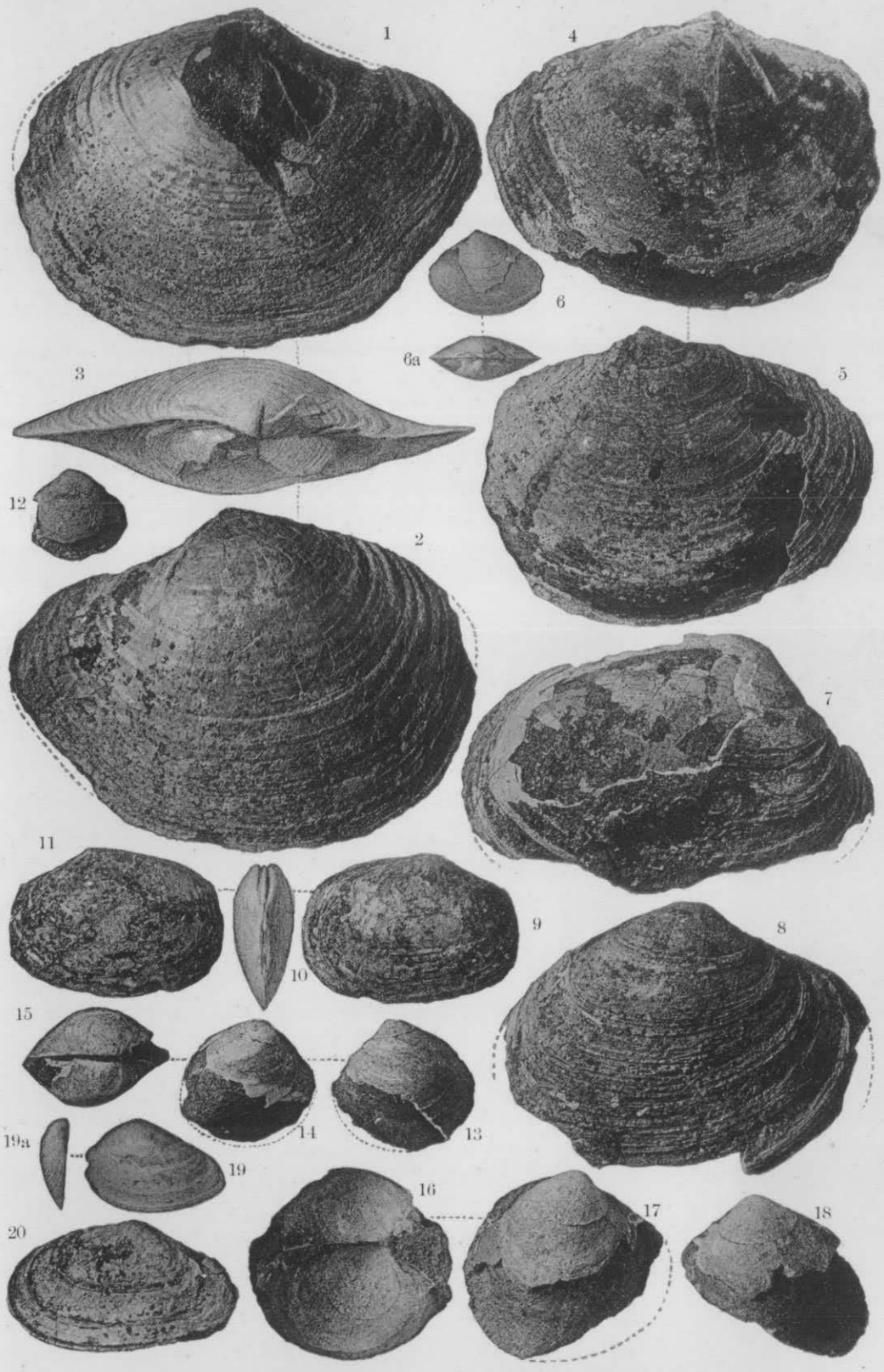


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PLATE III.

Plate III.

Fig. 1. Cardium squalidum n. sp. Left valve. 1a. Front-view. Tōkai Coal-Mine, Dōdaira. P. 16.

Figs. 2. Thyasira bisecta Conr. Worn specimen. Upper course of the Okegasakusawa, Uchigō-mura. P. 18.

Figs. 3, 4. Papyridea (Fulvia) nipponica n. sp. 3. Imperfect right valve. 4. Young perfect right valve enlarged. Tatsuta Coal-Mine (Entrance side) P. 17.

Figs. 5, 6, 7. Cardium (Laevicardium) tristiculum n. sp. 5, 6. Left valves Yamadaoka. 7. Right valve. Numanosaku. a. Shows depth. P. 16.

Figs. 8, 9. Venericardia sp. 8. Right valve. 9. Left valve. a. Depth. Dōdaira. P. 19.

Figs. 10, 11, 12. Venericardia tokunagai n. sp. 10. Right valve. 11. Left valve. 12. Umbonal view. Ōbisa. P. 18.

Figs. 13, 14, 15. Cardium shinjiense Yok. 13. Right valve. 14. Left valve 15. Umbonal view. Yamadaoka. P. 16.

Figs. 16, 17, 18. Venericardia laxata n. sp. 16. Left valve. 17. Right valve. 18. Front-view. Yotsukura. Coast. P. 19.

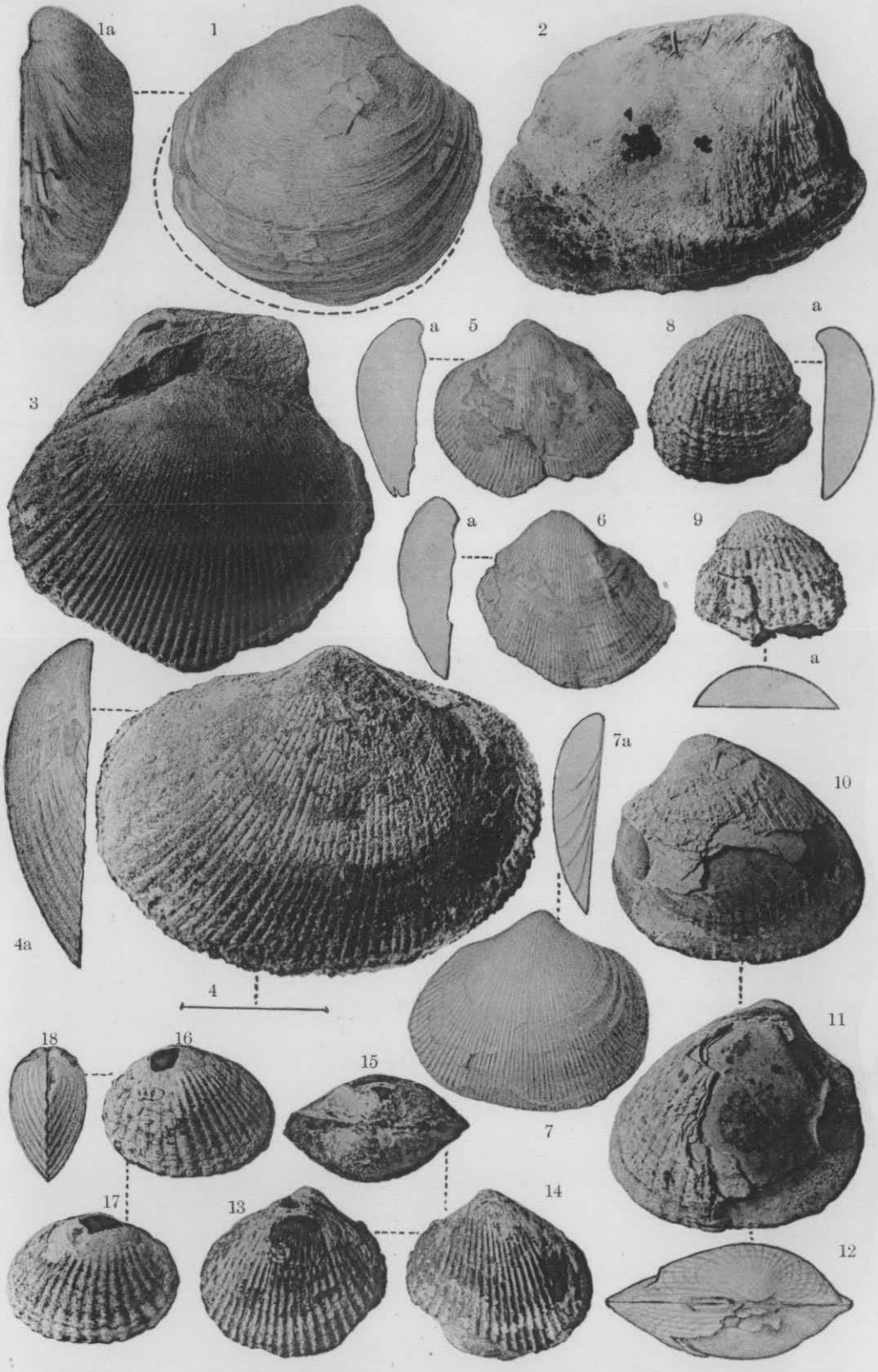

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PLATE IV.

Plate IV.

Figs. 1, 2. Venericardia pacifera n. sp. 1. Left valve. 2. View from front. Hannukizawa. P. 18.

Figs. 3. Lima yumotoensis n. sp. Left valve. a. Shows depth. Dainoyama, Yumoto. P. 20.

Figs. 4. Mytilus luciferus. n. sp. Left valves. Araya Coal-Mine, Oya. P. 19.

Figs. 5, 6. Mytilus takiensis n. sp. 5. Left valve. 6. View from front. Taki Coal-Mine. P. 20.

Figs. 7, 8. Modiola modiolus L. Right valves. 7. Dōdaira. 8. Takinakayama. P. 20.

Figs. 9? 10. Leda yabei n. sp. 9. Left valve. 10. Right valve. Tengasawa, Oyamada. P. 22.

Figs. 11, 12. Yoldia laudabilis n. sp. 11. Right valve. 12. View from beak-side. Shinyashiki, Suetsugu. P. 22.

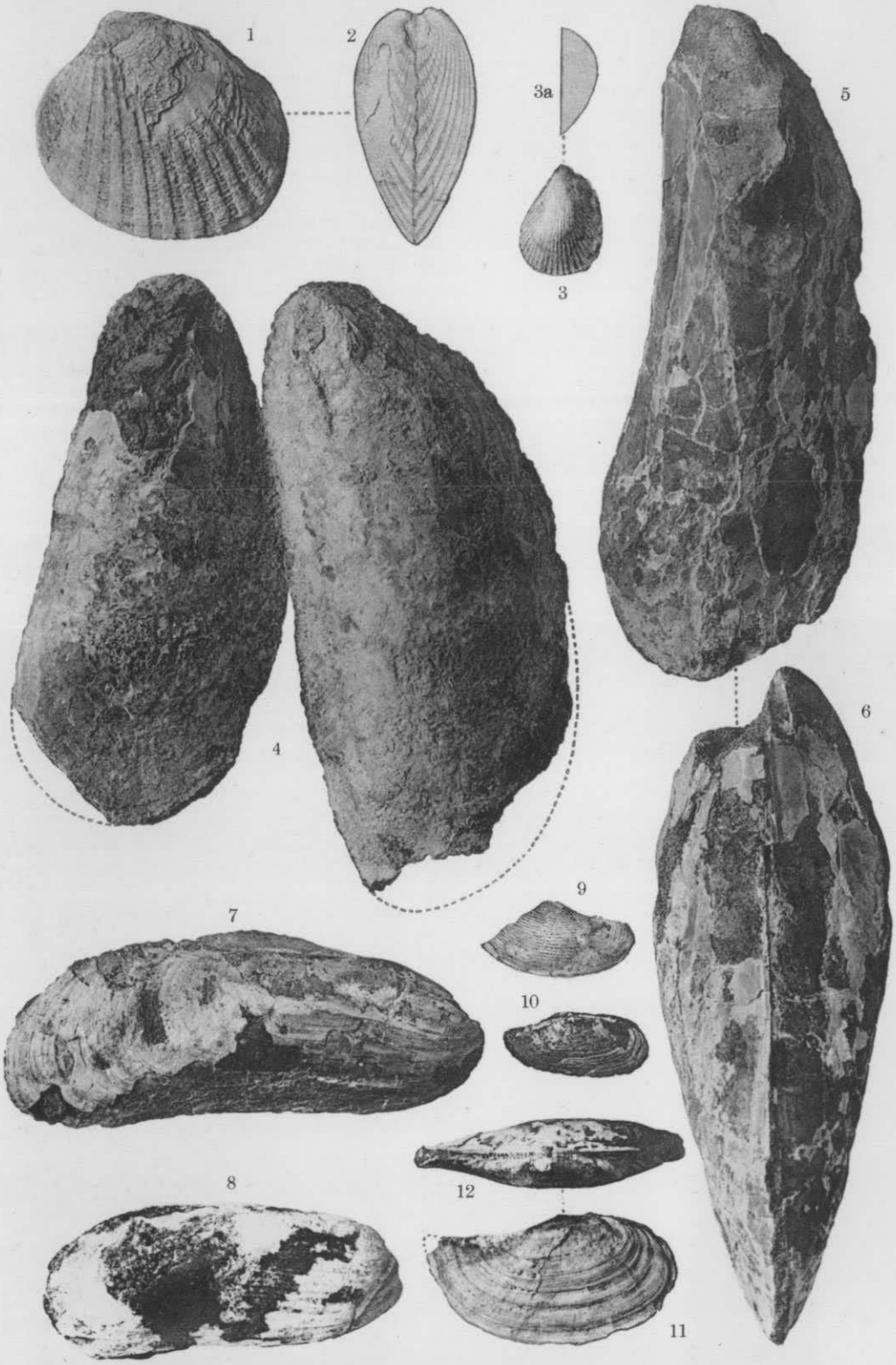

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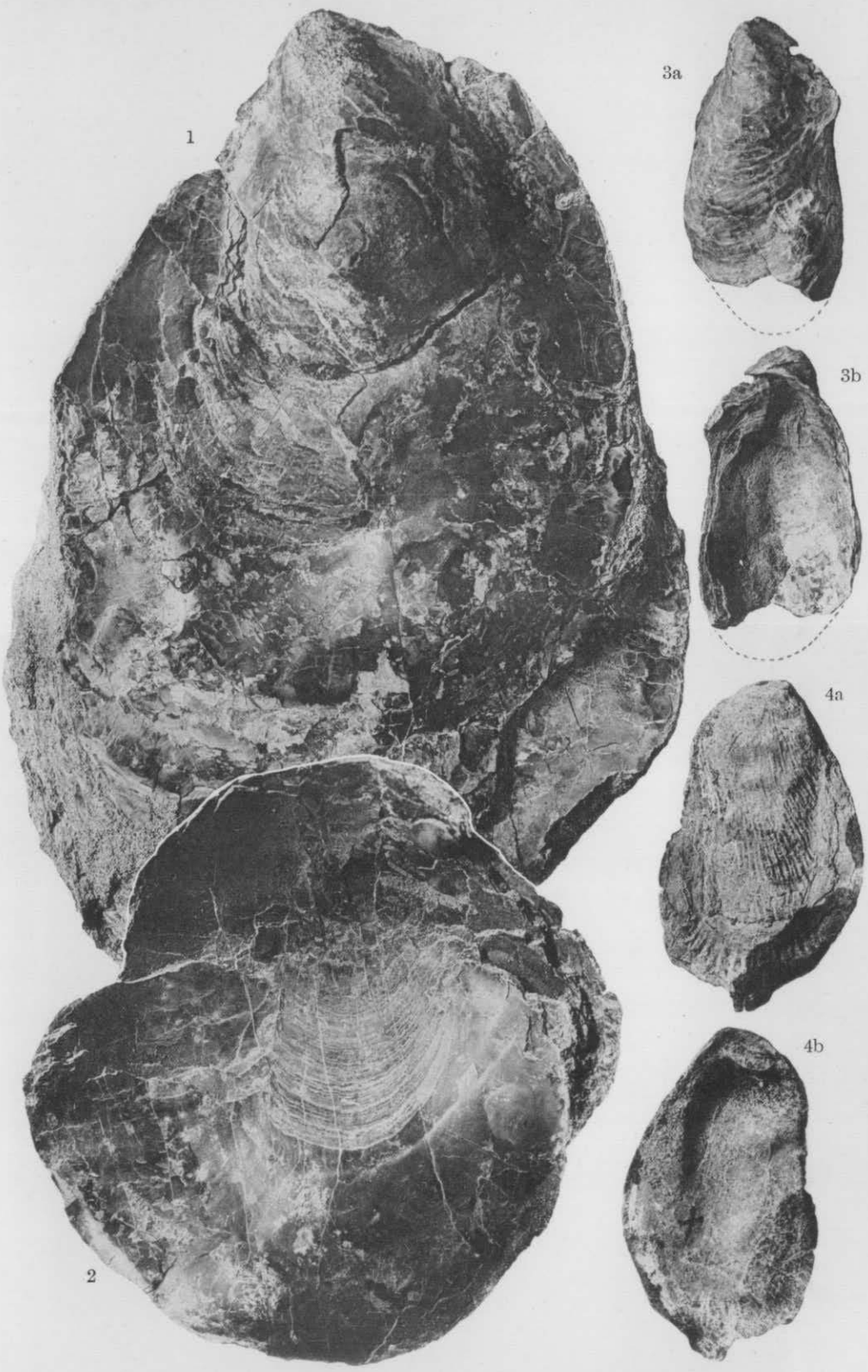
PLATE V.

Plate V.

Figs. 1, 2. Ostrea cfr. gigas Thunb. Inner side. Iwaki Coal-Mine, Tsuzura. P. 20.

Figs. 3. Ostrea takiana n. sp. Lower valve. a. Inside. b. Outside. Taki Coal Mine, Kadōno. P. 21.

Figs. 4. Ostrea mundana n. sp. Upper valve. a. Outside. b. Inside. In front of a building belonging to the Nakoso Coal Mine Co., Kubota. P. 21.



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