66. *The Tozenzi Sandstone.*

(Contributions to the Geology of the Zyôban Coalfield. IV.)

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The Tozenji sandstone¹⁾ is typically developed at Tozenzi near Yunoami, Izura coast near Otu, and Kokozura near Hirakata. The Tozenzi, occasionally heavily burden with calcareous nodules and richly fossiliferous, reposes on the folded Kamenô shale of the Yunagaya series at a little north of Izura as stated in Part II. At Izura the dark coloured sandstone is locally cross-bedded and is overlain by a loose, cross-bedded, ochre-coloured sandstone at the base of the tuff-argyllite of the Taga beds; the latter sandstone is, no doubt, an equivalent of the Usuba sandstone, though it is there not at all calcareous and devoid of fossils. At its very base lies a 10 cm thick layer of quartzose sandstone, by which it is separated from the underlying Tozenzi. Their boundary plane is plain-cut and quite distinct, in strong contrast to that between the Taga tuff-argyllite and the Usuba or Tenpizan sandstone. Whether the boundary represents an erosion unconformity as claimed by Tokunaga is questionable; yet it is sufficiently distinct for the stratigraphical separation of one formation from the other. The Tozenzi sandstone is a distinct formation well separable from the Taga beds, and decidedly older than, and not contemporaneous with the Usuba sandstone; this is good harmony with the fossil evidence, the molluscan fauna of the Tozenzi having an older aspect than that of the Taga fauna.

It is here to be added that the Tozenzi sandstone has loose, cross-bedded, ochre-coloured sandstone at its base, which is very similar in general aspect to the same rock overlying the Tozenzi at Izura; the loose sandstone rests unconformably on the fossiliferous Kamenô shale. The stratigraphical relation is visible in good exposures of those deposits along a streamlet at a little north of Tozenzi.

The Kokozura sandstone of Sokabe, already referred to in Part II of the present work, is more comprehensive than the Tozenzi sandstone, comprising also the Taga beds in the writer's sense. In his sense, Sokabe is correct in re-

1) In Part II, the writer used the term the "Kokozura sandstone" for the Tozenzi bed of Tokunaga, unfortunately forgetting the latter name which has priority. It is the Tozenzi sandstone in Part III and the present note.

ferring the deposits overlying the *Vicarya* beds of the Sirado series in the small valley of Hutatuzima to the Kokozura sandstone. In the new light of the stratigraphy of the Taga beds expounded in Part III, the sandstone with numerous boulders of older, hard rocks exposed at the Hutatuzima mineral-water bath is seen to be correlative with the Usuba sandstone, as it underlies the Taga tuff-argyllite which continues southward to the same rock covered by the Tenpizan sandstone; the Tozenzi sandstone is there lacking between the Usuba sandstone and the underlying *Vicarya* beds. The unconformable relation of the Taga beds and the *Vicarya* beds of this place has sometimes been doubted on the two following accounts: 1, the boulder bed of the mineral-water bath may possibly be a younger terrace deposit, and 2, the sandstone and gravel deposit exposed at a spot several scores of meters upstream appears as if being interbedded in the *Vicarya* beds. Very lately, the writer, with Y. Kamada, revisited this place and found the observation of Sokabe to be quite correct. The boulder bed exposed at the two spots certainly belongs to a geological formation, the Usuba sandstone, which rests unconformably upon the *Vicarya* beds and is covered by the Taga tuff-argyllite; it is neither a young terrace deposit nor interbedded in the *Vicarya* beds.

In 1925, M. Yokoyama²⁾ described the following molluscan fossils from the Tozenzi sandstone of Izura:

Drillia principalis Pilsbry

Pleurotoma sp.

Voluta megaspira Sowerby (?--*Fulgolaria prevostiana* (Crosse))

Chrysodomus phoeniceus Dall

Galeodea (*Scontia*) *japonica* Yokoyama (?--*Phaliun yabei* Nomura and Hatai)

Turritella nipponica Yokoyama

Natica janthostoma Deshayes

Sigaretus (*Eunaticina*) *papilla* Gmelin

Mastra spectabilis Lischke

Macoma izurensis Yokoyama

M. dissimilis v. Martens?

Clementia (*Compsomyax*) *iizukai* (Yokoyama)

Venus (*Mercenaria*) *stimpsoni* Gould

Lucina (*Lucinoma*) *acutilineata* Conrad

2) M. Yokoyama: Molluscan Remains from the Uppermost Part of the Joban Coal-field. Jour. Coll. Sci. Imp. Univ. Tokyo, Vol. XIV, Art. 5, 1925.

Pecten yessoensis Jay

Pecten (Patinopecten) kimurai Yokoyama

Nuculana confusa (Hanley)

Later S. Nomura³⁾ reported on the occurrence of many other forms at the same locality :

Dentalium yokoyamai Makiyama

D. yamakawai Yokoyama

Buccinum leucostoma Lischke

Cylichna orientalis Yokoyama

Fulgolaria (Psephaea) prevostina (Crosse)

Nassarius cf. *japonicus* (A. Adams)

Phalium yabei Nomura and Hatai

Polynices (Neverita) didymus (Bolton)

Sinum japonicum Lischke ?

Surculites (Megasurcula) yokoyamai Otuka

Solidula stligosa Gould

Cardium (Clinocardium) shinjiense Yokoyama

Clementia (s.s.) *vathletii* Mabile

Cultellus izumoensis Yokoyama

Macoma optiva (Yokoyama)

M. praetexta (v. Martens)

M. tokyoensis Makiyama

Nuculana robai (Kuroda)

Ostrea gigas Thunberg

Venericardia ferruginea (A. Adams)

Yoldia naganumana (Yokoyama)

More lately M. Eguchi collected another species

Thyasira nipponica Yabe and Nomura

In total, 39 species of molluscs are now known from this place. Of them, *Voluta megaspira* Sowerby and *Galeodea japonica* Yokoyama may, according to Nomura, possibly be identical with *Fulgolaria prevostina* (Crosse) and *Phalium yabei* Nomura and Hatai respectively; if so, then the total number is reduced to 39.

Most characteristic to this molluscan fauna is *Clementia iizukai* originally referred by Yokoyama to *Meretrix* and later transferred by Nomura to *Clementia*

3) S. Nomura: *Clementia (Compsomyax) iizukai* (Yokoyama). Saito Ho-on Kai Mus. Research Bulletin, No. 19, 1940.

(*Compsomyax*). The former author cited the following localities of this species: 1, Between Niida and Simoyamada; 2, Takakurazi; 3, Harakida; 4, Kokozura near Hirakata; 5, Izura; 6, Yunoami (Tozenzi); 7, Sukegawa (Turusihama and Hatuzaki). A few remarks are needed about the geological formations, with the fossil, of these localities:

1. Between Niida and Simoyamada. There is a geological formation lying unconformably upon the Nakayama tuffite and *Vicarya* beds of the Shirado series and beneath the "Ona sandy shale" of K. Watanabe; it belongs, the writer believes, to the Tozenzi sandstone.

2. Takakurazi. Correctly Kozosi, Ueda-mati. Tokunaga who supplied to Yokoyama the material of this and several other species from this locality, noted the mother rock as a pumiceous tuff (with marl) and correlated it with the Nakayama tuff, while later K. Watanabe mapped this area as the "Ona sandy shale." The "Ona sandy shale" of this area, in general, is an equivalent of the Taga tuff-argyllite of the writer; but it is also possible that the mother rock is the Tozenzi sandstone, as it is said to contain marl, by which term Tokunaga probably means marl nodules. This locality is only 1 km diametrically distant from the preceding one.

3. Harakida, near Onahama. Numanouti bed according to Y. Kamada who considers it as an equivalent of the Tozenzi sandstone.

4. Kokuzura; 5, Izura; 6, Yunoami (Tozenzi). All the typical localities of the Tozenzi sandstone.

7. Sukegawa (Turusihama and Hatuzaki). The Tenpizan sandstone of the writer.

In the present knowledge, the geological range of *Clementia iizukai* is from the Tozenzi sandstone to the Tenpizan sandstone. On the other hand, *Macoma optiva* Yokoyama, which is a species common to the Tozenzi and the Nakayama, is not yet known from the Taga beds.