ON THE OCCURRENCES OF ATURIA IN PROVINCES OF ETCHU AND IWAMI AND THEIR BEARING ON THE PALAEOFLUMENOLOGY IN THE MIocene OF JAPAN.*

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It was over 10 years ago that the junior author had discovered a specimen of *Aturia* from the Miocene Yatsuo series1) at Tsuzara, near Sasazu in Etchu, Toyama Prefecture, as reported already by him (1946). It belongs now to the collection of the Geological Institute, Hiroshima University. Lately this specimen in addition to another nautiloid from Iwami, Shimane Prefecture, were sent by IMAMURA to the senior author for study. The former is identified here with *Aturia minoensis*, recently described by the senior author (1954). He visited then the locality with TSUDA as a guide and confirmed its being a necroplanctonic float.

Before describing these specimens and discussing their palaeoflumenological bearing on the *Proto-Tsushima oceanic current*, the authors wish to thank Prof. Sotoji IMAMURA of the Hiroshima University and Mr. Karyu TSUDA, lecturer of the Niigata University.

*Aturia minoensis* KOBAYASHI

Plate 1, Figures a-d. 1954. *Aturia minoensis* KOBAYASHI, Japan. *Jour. Geol. Geogr.* vol. 25, p. 35, pl. 5, figs. a-d; text-fig. 1.

Description:—The Tsuzara specimen is smaller than the holotype from Hazamagahara of Togari, its maximum radius being 41 mm. where the whorl is 18.5 mm. in breadth. In the same section the

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1) The sequence of the Yatsuo Series
   - Otogawa (菅川) Series
     - Yatsuo (八尾) Series
     - Joyama (堅場) beds
     - Kurosedani (黒瀬谷) beds
     - Iwaine (岩根) beds
     - Nirehara (緑原) beds
   - Kusuhara (久津原) alternations of mudstone, sandstone and conglomerate
   - Kakehata (掛け畑) conglomerate, sandstone and mudstone
   - Kamikurose (上黒瀬) alternation of sandstone and mudstone

2) 富山県上新川郡大浜町前原土川
radius of the penultimate whorl is 15mm. The siphuncle of the ultimate whorl is located at a distance of about three-fourths the length from its venter to that of the penultimate whorl.

Both of these specimens are middle Miocene in age and agree with each other in all of the observable characters, namely in the mode of coiling, whorl section, septal distance and so forth. The ventral saddle is subsquare but with a shoulder on each side and the lateral side a little sigmoidal. Starting from the preceding shoulder, the septal suture describes a large semi-circle on the flank which is more strongly convex on the inner than on the outer side.

The conch is compressed laterally with the result that the septa in the inner volutions are seen to be broken into pieces. A part of the outer shell remains on a flank of the last whorl, but no surface marking is preserved.

For the comparison of this species with its allies the reader is referred to the senior author's paper (1954).

**Occurrence:** Dogawa, Tsuzara, Osa-wano-town, Kami-shinkawa-gun, Toyama Prefecture; middle Miocene Kurosedani beds of the Yatsuo series.

The upper division of the Kurosedani beds which is called Kashio, is marked off from the upper Miocene Joyama beds by a thin layer of sandy tuff. At the cliff of Dogawa a few other layers of sandy tuff are intercalated in the mudstone beds. In addition there are two wedges of conglomerate in the sequence, which contain pre-Tertiary rocks, andesites and reworked angular mudstones. The upper wedge whence the *Aturia* specimen was procured is about 1.2 m. at the thickest and contains many shells most of which are however broken. *Patinopecten kimurai*, *Chlamys nisataiensis*, *Venericardia*, *Glycymeris*, *Siphonalia* and *Turritella yoshidai* are common members. It is noteworthy that Tsudo obtained two fragmentary shells of *Nautilus* at this small wedge. While the wedges of conglomerate are warm shallow sea sediments, the mudstone must be a much deeper and cooler bottom sediment not only because of its fineness, homogeneity and uniformity but also because thin shelled *Yoldia* and *Propaeamusseum* are found scattered in it.

Because intraformational folds are occasionally found in the mudstone beds at other places, it is probable that the conglomerate wedges are shifted blocks slipped down on the off-set plane of a fossil delta.

The Kashio division is thus composed of mudstone, sandstone, conglomerate and sandy tuff and yields *Operculina* and *Miogypsina* beside them. The oceanographic situation at that time is presumed to be similar to that of the Toyama bay at present in the respect that the surface water was warm but the deep one cool.

The middle division of the Kurosedani beds called Kakehata consists of similar alternations. According to Oyama (1950), the *Telescopium-Geloina* bioocoenosis in it comprises about 40 species in *Littorionopsis* (*scabra* group), *Telescopium, Rhizophorimurex, Geloina* and so forth. Noting that *Batillaria, Corithidea, Stenothyra* and *Glaucone* live in hypohaline waters, the former two are found only in tidal zone, *Natica, Tritia, Decolifer, Estelacar, Scapharca, Joannisella, Cyclina* (*s. str.*) and *Clementia* (*s. str.*) found in hypohaline waters and from the tidal zone down to deeper waters, and *Tatwivaia, Vicaryella* and *Vicaryya* may be considered tidal zone dwellers, etc., he emphasized the mangrove swamp for the habitat of these Molluscs.
Bunolophodon is known to occur in the Kamikurose alternation of sandstone and mudstone in the lower part of the Kurasedani beds and Liquidambar formsa HANCE and Comptoniphyllum nau mannii NATHORST in this and middle divisions. These plants indicate warm land climate.

Returning to the cephalopods, the coexistence of two Nautili and one Aturia, all fragmentary, in a small wedge of conglomerate is a remarkable fact because Aturia and Nautilus are both rare genera in the Miocene of Japan. As mentioned above, it is recognizable that a warm current was flowing along the coast of this region in the middle Miocene epoch. It is known further that living Nautilus happens to come ashore. Its usual habitat is, however, at the bottom in a deep water. Furthermore, if considered that gregarious occurrence of the rare fossils (KOBAYASHI, 1954), these Nautiloids must be necroplanktonic floats.

Prof. Shozo Monji of the Botanical Institute, University of Tokyo kindly informed the senior author of the fact that the northern limit of mangrove swamps may be Okinawa of the Ryukyu islands where is a natural forest of Bruguiera gymnorrhiza LAM. at Yagagishima, Hane-village, Kunigami-gun, although its occurrence is reported from Atumi-Oshima. A few bushes of Kandelia Rheedii WRIGHT et ARN. at Kinyu village, Ibuzuki-gun, and Kaseda village, Kawabe-gun, both in Prov. Satsuma, Kagoshima Prefecture, Southern Kyushu, are said in traditions to have been imported from the Ryukyus in 1614 (NAKANO, 1920). Assuming the northerly shifting of isotherm for some 10 degrees of latitude in the middle Miocene epoch which is suggested by the Telecoipium-Geloina biocoenosis, Nautilus would have been able to thrive near Formosa as does in the central Philippines.

Miocene was the time of a great submergence for Japan. As discussed elsewhere (KOBAYASHI, 1941), there was already the Proto-Japan sea. The distribution of Vicaryia, Miogypsina-Operculina and other fossils warrants that there was the Proto-Tsushima current on the continental side of the insular arc. Therefore it is highly probable that Aturia miniensis in question as well as indeterminable Nautili associated with it in the same conglomerate wedge have flown by the current from the south or possibly from off Formosa or Yaeyama islands of the Ryukyus and found a place to settle in this region.

Aturia sp. indet.

Plate 1, Figures e-f

This specimen was obtained from the Miocene Togane formation at Senjojiki of Togane, near Hamada, Province Iwami, Shimane Prefecture. From the other Molluscans OTUKA (1937) concluded that the Togane formation is contemporaneous with the Lower Kadonosawa Series in Province Mutsu, North Japan, but noted that the fauna of the former is different from that of the latter in the lack of any cold water element. The Lower Kadonosawa series is the Kadonosawa proper the age of which is middle Miocene (HANZAWA, 1954).

The chambered shell with a siphuncle belongs undoubtedly to a nautiloid. As seen in the magnified figure, septa are prolonged into long funnels from their
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necks. They are each invaginated into the preceding funnel almost as long as the septal distance. There is a narrow space between any two funnels, but whether or not there was a connecting ring in this place (MILLER and FURNISH, 1938) cannot be answered with this weathered specimen.

As it has a holochoanoidal siphuncle, it belongs evidently to Aturia which is the only Miocene survivor among the Hercoglossa-Aturia group (MILLER, 1949) and a sole genus of the kind so far known from the Tertiary of Japan. Its septal distance is as short as that of Aturia minoensis with which it is nearly coeval. In this state of preservation, however, it is extremely difficult to make an exact specific identification.

Though fragmentary, it is worth while to describe not only because of its new find in this area, but also because it vindicates the above suggested course of the Proto-Tsushima current.

References


MASATANI, K. (1946), On Aturia discovered in the Yatsuo Series. _Hokokudan-shi of Toyama College._ No. 4.


Explanation of Plate 1

Figures 1-4. _Aturia minoensis_ KOHAYASHI from the middle Miocene Kurosedani beds of the Yatsuo series at Dogawa. Tsuzara, Osawano-town, Kami-shinkawagun, Toyama Prefecture, (Province Etchu). One and a half times magnified.

Figure 5. _Aturia_ sp. indet. from the Miocene Togane formation at Senjojiki of Togane near Hamada, Shimane Prefecture (Province Iwami). Twice magnified.

These two specimens are kept in the Geological Institute, Hiroshima University.