

Discovery of the Hauterivian Deposit at Besavoa, Northwest-by-west of Betioky, Madagascar*

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Introduction

In 1973 and 1975, the members of the National Science Museum, Tokyo carried out a reconnaissance survey of the paleontology of Madagascar (ASAMA, 1977). In the first half of the period in 1975 (Sept. 1–Sept. 15), ASAMA, HASEGAWA, MATSUBARA, RAKOTOARIVELO and THEODORE carried out field work in Tuléar and collected fossil vertebrates, ammonites and plants in the Tuléar region. At several localities near Betioky, southeast of Tuléar were newly discovered Lower Cretaceous ichthyosaurs and plesiosaurs in association with molluscs. The finding of these reptiles in Madagascar may be significant when one wants to consider the distribution and evolution of these marine reptiles.

In the last week of the later half of the period (Sept. 19–Oct. 10), OBATA provisionally identified ammonites obtained from Besavoa near Betioky at the laboratory of the Service Géologique de Madagascar, Tananarive. Specimens collected in 1975 are still left there packed without being subjected to any research because of the delay of a permission from Madagascar Government.

This is a report on the ammonite assemblages obtained from Besavoa and their stratigraphic significance. The 1975 National Science Museum Party, by permission of the Malagasy Government, carried out field work, in cooperation with the Service Géologique, Direction des Mines et de l'Energie, Repoblika Malagasy. The authors are deeply indebted to Mr. RASOAMAHENINA-ANDRIAMAZOTO, Chief of the Service Géologique, who kindly made arrangements for the field work, and allowed the authors to utilize facilities and equipment of the Service Géologique. The study was financially supported by a Grant in Aid for Overseas Scientific Survey, from the Ministry of Education, Science and Culture of Japan.

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formation on localities and photographs of the ammonite specimens.

Stratigraphic Notes

On the Betioky sheet of the 1:100,000 geological map (Service Géologique de Madagascar, 1965), the Mesozoic sequence of the area is summarized in ascending order as follows.

- K²: Sakamena Shale bearing *Glossopteris* and reptiles
- I: Isalo Sandstone containing shales
- J_{II-IV}: Bajocian to Bathonian—coral limestone
- IJ_I: Upper Bathonian—limestone, sandstone, *Cadomites*, *Anabacia*, green sandstone with siliceous wood.
- J¹: Callovian—limestone, oolite, *Macrocephalites*, *Pygaster*
- C_{II}: Hauterivian—glauconite-bearing green sandstone, characterized by *Saynella* and *Duvalia*
- Barremian?—glauconite-bearing green sandstone characterized by *Paracrioceras*
- C⁷⁻³: Albion—sandstone characterized by *Pervinqueria* and *Douvilleiceras*
- Cenomanian—*Acanthoceras*, *Mantelliceras*
- Turonian—sandstone characterized by *Romaniceras* and *Fagesia*
- Coniacian—sandstone and marl characterized by *Barroisiceras*
- β: basaltic flow and neck
- C⁹⁻⁸: Campanian—calcareous sandstone characterized by *Alectryonia*
- Maastrichtian—calcareous sandstone characterized by *Pachydiscus compressus*

A brief geological map on the northwestern area of Betioky (Fig. 1) is adapted from the map published by the Service Géologique in 1965. The localities where the party collected some ammonites are shown in Fig. 2. The suggested geological ages on the basis of ammonite assemblages are indicated in brackets.

The molluscan species from locs. 1~3 and 5 are listed in the next chapter. From loc. 4 several specimens belonging to a few ammonite genera as exemplified by stephanoceratids, numerous pelecypods and several echinoids were obtained. A few specimens belonging to three ammonite genera as exemplified by perisphinctids, thirteen specimens of belemnite, a few pelecypods, brachyopod and crinoids were yielded from loc. 6. From loc. 3' *Mantelliceras* cf. *M. betiokiense* COLLIGNON and *Plesioturritiles* (?) sp. were identified. *Turritiles* cf. *T. acutus* PASSY, *Paraturritiles* cf. *P. cenomanensis* SCHLÜTER, *Mantelliceras* cf. *M. ampakabense* COLLIGNON, *M.* cf. *M. betiokyense* COLLIGNON, and *M.* cf. *M. agrawali* COLLIGNON, etc. were distinguished among the specimens from loc. 7.

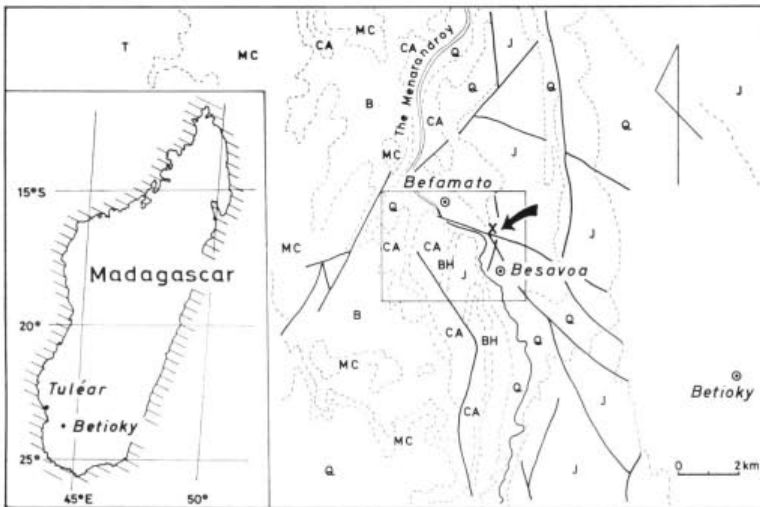


Fig. 1. Geological sketch map of the northwestern Betioky area. The arrow indicates the newly found Hauterivian outcrop (adapted from SERVICE GÉOLOGIQUE DE MADAGASCAR, 1965).

Q: Quaternary, T: Tertiary, MC: Masstrichtian—Campanian, B: Basalt, CA: Coniacian—Albian, BH: Barremian?—Hauterivian, J: Jurassic



Fig. 2. Fossil localities surveyed near Besavoa and Befamato (adapted from HASEGAWA, 1976).

Hauterivian Deposit

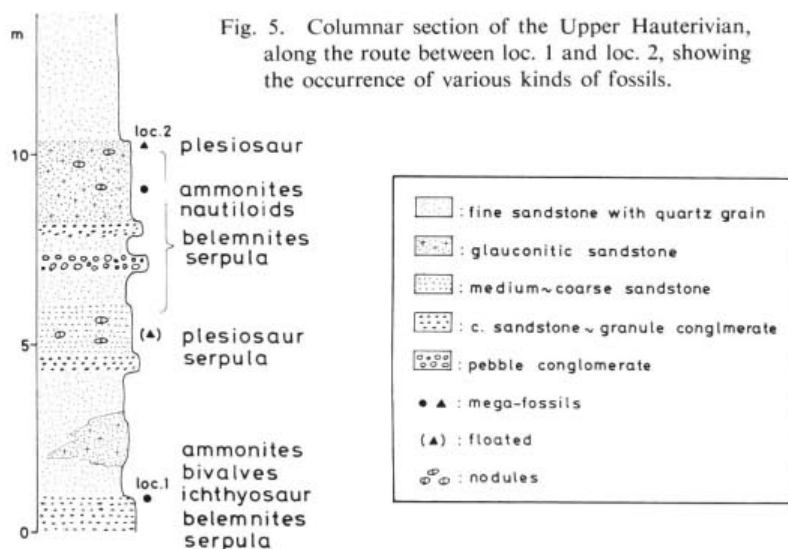
A columnar section (loc. 1–loc. 2) at the small branch of the Menarandroy, about 1 km north of Besavoa is shown (Figs. 3, 5). The strata dip gently eastwards, showing several degrees. The formation, which was formerly regarded as Jurassic



Fig. 3. An eastern branch of the Menarandroy River between Befamato and Besavoa. Strata are observable along the river banks from loc. 4 to loc. 2.



Fig. 4. An example of ammonite occurrence at loc. 5 in the Hauterivian deposit.



(Service Géologique de Madagascar, 1965), is characterized by glauconitic sandstone intercalated with quartzose sandstone and conglomerate. Calcareous nodules are frequently contained in the sandstone (Fig. 4).

The strata at loc. 3, about 2 km west of Besavoa, consist of quartz-rich coarse-to medium-grained sandstone with glauconite and calcareous material. Thus the strata closely resemble those at loc. 1 in lithology and their stratigraphic position may be slightly lower than that of loc. 1. In short, the lithology is very similar to that described by BESAIRIE (1972) on the Hauterivian deposit at southern Onilahy area. According to him (1972, p. 406), the Hauterivian deposit is 20 m thick in the Betioky area: it overlies the Callovian deposit transgressively, and is characterized by glauconite sandstone which often contains *Menuthiocrioceras*, *Saynella*, belemnites and *Duvalia*.

The following fossils (see Plates 1–4) were obtained from the outcrops.

Loc. 1: *Menuthiocrioceras sornayi* COLLIGNON

M. mahafalense COLLIGNON

Belemnites pistilliformis BLAINV.

B. subfusiformis BLAINV.

Serpula (Tubulostium) sp.

pelecypod spp.

ichthyosaur sp.

Loc. 2: plesiosaur sp.

Loc. 3: *Menuthiocrioceras sornayi* COLLIGNON

M. ampakabense COLLIGNON

M. sp.

Leopoldia (?) spp.

Phylloceras spathi COLLIGNON

Phylloceras sp.

Saynella aff. *S. besairiei* COLLIGNON

S. saintoursi COLLIGNON

Belemnites pistilliformis BLAINV.

B. subfusiformis BLAINV.

nautiloid sp.

pelecypod spp.

Serpula (Tubulostium) sp.

plesiosaur sp.

ichthyosaur sp.

Loc. 5: *Menuthiocrioceras mahafalense* COLLIGNON

M. sp.

Phylloceras spathi COLLIGNON

Saynella besairiei COLLIGNON

ammonoid gen. et sp. indet.

nautiloid sp.

Belemnites pistilliformis BLAINV.

B. subfusiformis BLAINV.

pelecypod spp.

Serpula (Tubulostium) sp.

In summary, above mentioned assemblages of ammonite are very similar to those cited in BESAIRIE (1972, p. 406), and are safely assigned to *Saynella besairiei* Zone, approximately upper Hauterivian in the international scale (COLLIGNON, 1962). This is a new discovery: the extension of Hauterivian deposit has not previously been reported from the area including locs. 1, 2 and 5 (BESAIRIE, 1976).

Concluding Remarks

The biostratigraphic significance of the ammonite fauna found from the outcrop in an eastern branch of the Menarandroy River at about 1 km north of Besavoa, north-

west-by-west of Betioky has been described. The fossil-bearing strata are newly assigned to the Upper Hauterivian, judging from the similarity in the contained ammonite species and in sedimentary facies to those in the southern Ranonda and Mikaikarivo areas, west of Betioky.

As shown in the columnar section (Fig. 5), the ammonite assemblage represented by *Menuthiocrioceras* and *Saynella* species from the glauconitic sandstone or conglomerate is frequently associated with plesiosaur and ichthyosaur bones. As a result of ammonite identification the geological age of these reptiles is safely concluded as Hauterivian in the international scale. The Hauterivian plesiosaur and ichthyosaur bones are expected in the southern Ranonda to Mikaikarivo areas, west of Betioky.

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Explanation of Plates

Plate 1

- Fig. 1. *Menuthiocrioceras sornayi* COLLIGNON. Ventral (a) and lateral (b) views (both $\times 1/3$). Loc. 3, about 2 km west of Besavao, northwest-by-west of Betioky.
- Fig. 2. *Menuthiocrioceras mahafalense* COLLIGNON. Ventral (a) and lateral (b) views (both $\times 1/2$). Probably loc. 5, about 1 km north of Besavao, northwest-by-west of Betioky.

Plate 2

- Fig. 1. *Phylloceras* sp. Cross-section ($\times 1/2$). Loc. 3, about 2 km west of Besavao, northwest-by-west of Betioky.
- Fig. 2. *Phylloceras spathi* COLLIGNON. Cross-section (a) and lateral (b) view (both $\times 1/2$). The same locality as above.
- Fig. 3. *Menuthiocrioceras sornayi* COLLIGNON. Lateral (a) and ventral (b) views (both $\times 1/2$). Loc. 1, about 1 km north of Besavao, northwest-by-west of Betioky.

Plate 3

- Fig. 1. *Saynella* aff. *S. besairiei* COLLIGNON. Fragmentary cross-section (a) and lateral (b) view (both $\times 1/2$). Loc. 3, about 2 km west of Besavao, northwest-by-west of Betioky.
- Fig. 2. *Saynella saintoursi* COLLIGNON. Lateral view (a) and cross-section (b) (both $\times 1/2$). The same locality as above.
- Fig. 3. *Saynella besairiei* COLLIGNON. Lateral view ($\times 1/3$). Probably loc. 3, about 1 km north of Besavao, northwest-by-west of Betioky.

Plate 4

- Fig. 1. *Menuthiocrioceras* cf. *M. mahafalense* COLLIGNON. Lateral view ($\times 1/3$). Probably loc. 1, about 1 km north of Besavao, northwest-by-west of Betioky.
- Fig. 2. *Menuthiocrioceras* sp. Dorsal view of a fragment ($\times 1/3$). Probably loc. 3, about 2 km west of Besavao, northwest-by-west of Betioky.
- Fig. 3. Ammonoid gen. et sp. indet. Lateral (a) and ventral (b) views (both $\times 1/2$). Loc. 5, about 1 km north of Besavao, northwest-by-west of Betioky.







