

Colour markings in two species of tetragonitid ammonites from the Upper Cretaceous of Hokkaido, Japan

Kazushige TANABE* and Yasumitsu KANIE**

(With 3 text-figures and one plate)

北海道上部白亜系産アンモナイト *Tetragonites* 2 種の色模様

棚部一成*・蟹江康光**

北海道小平地域に分布する上部白亜系, 下部チューロニアンおよび下部サントニアン (Text-fig. 1) から色模様の保存されたアンモナイト *Tetragonites* sp. (Pl. 1, Figs. 1a-b; Text-fig. 2) と *Tetragonites glabrus* (JIMBO) (Pl. 1, Figs. 2a-b) がそれぞれ 1 個体発見されたので, ここに記載する。両種とも色模様は, 指紋状の表面構造を持つ最外層のみに認められる。*T. sp.* は, へそ周辺と内側面の淡褐色の基地に濃褐色鋸歯状の放射色帯を持ち, 色帯の様式は現生オウムガイ類のそれ (Text-fig. 3) に類似する。一方 *T. glabrus* の色帯は, *T. sp.* のそれと異なり, 淡褐色の側面上に, 成長方向に平行な濃褐色の 1 本の帯として存在する。

Introduction

Colour patterns are commonly observed on the outer shell surface of living molluscs and brachiopods. They are, however, rarely preserved in Paleozoic and Mesozoic fossil molluscs including ammonoids. Although several examples of colour markings in ammonoids have been reported from the Triassic and the Jurassic sediments of Europe and North America (e.g. GREPPIN, 1898; SCHINDEWOLF, 1928, 1931; SPATH, 1935; ARKELL, 1957; REYMENT, 1957; PINNA, 1972; TOZER, 1972), few are known from the Cretaceous, other than three species of the Texanitinae described by MATSUMOTO & HIRANO (1976) from the Santonian of Hokkaido.

The Upper Cretaceous ammonoids in the meridional zone of Hokkaido occur abundantly in an excellent state of preservation in calcareous marly or sandy nodules; it has therefore been expected to find still more species with colour markings. Recently, the senior writer recognized colour markings on two specimens of two tetragonitid ammonites, *Tetragonites* sp. and *T. glabrus* (JIMBO), stored in the type collection of Kyushu University. In this paper the writers describe the colour markings in the two species and compare them with those of previously described ammonoids and living *Nautilus*.

* 九州大学理学部地質学教室 Department of Geology, Kyushu University, Fukuoka 812, Japan.

** 横須賀市博物館 Yokosuka City Museum, Yokosuka 238, Japan. Manuscript received Aug. 1, 1978. Contribution from the Yokosuka City Museum, No. 269.

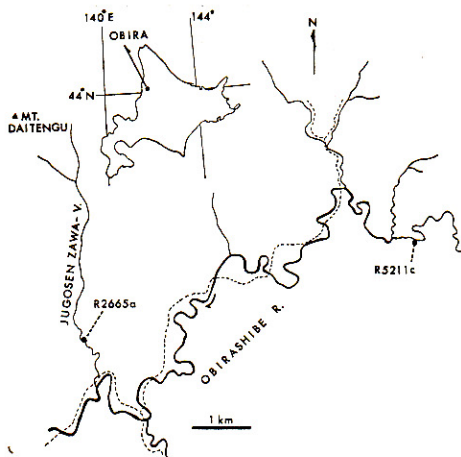


Fig. 1. Map of the Obira area, northwestern Hokkaido, showing the locations of ammonoids with colour markings. R 5211c: locality of *Tetragonites* sp. R 2665a: locality of *Tetragonites glabrus* (JIMBO).

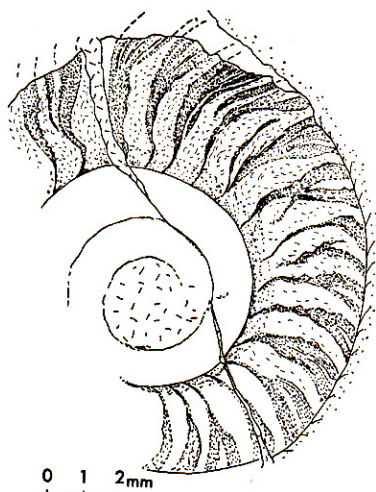


Fig. 2. Enlarged drawing of inner flank and umbilical area of a specimen of *Tetragonites* sp. (GK. H. 5870) showing serrate radial stripes.

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Geological setting of the specimens studied

Two species of *Tetragonites* with colour markings were collected from the Upper Cretaceous deposits exposed along the Obirashibe River and its tributaries in the Obira area, northwestern Hokkaido by T. MATSUMOTO, H. HIRANO and K. TANABE in 1973 (Text-fig. 1).

Tetragonites sp. was collected from a calcareous marly nodule embedded in silty mudstone at Loc. R 5211c, upper stream of the Obirashibe River, about 500 m east from the junction of this river with the Kanajirizawa. It occurred together with *Inoceramus (Mytiloides) labiatus* (SCHLOTHEIM), *I.* (s. l.) aff. *saxonicus* PETRASCHECK, and *Sciponoceras orientale* MATSUMOTO et OBATA.

T. glabrus was collected from a calcareous marly nodule embedded in clayey mudstone at Loc. R 2665a, the lower stream of the Jugosenzawa, a tributary of

the Obirashibe River. Important associated are *I. (Platyceramus) amakusensis* NAGAO et MATSUMOTO, *I. (Sphenoceramus) naumanni* YOKOYAMA, *Damesites damesi* (JIMBO), *Gaudryceras denseplicatum* (JIMBO) and *Neopuzosia ishikawai* (JIMBO).

According to the stratigraphic divisions proposed by TANABE *et al.* (1977), Locs. R 5211c and R 2665a are included in the Zones of *I. labiatus* (Lower Turonian) and *I. amakusensis* (Lower Santonian) respectively.

Descriptions of the colour markings

1. *Tetragonites* sp. (Pl. 1, Figs. 1a-b; Text-fig. 2)

Material: Kyushu University registered number (GK. H) 5870 from Loc. R 5211c, upper course of the Obirashibe River (Lower Turonian).

Description: The outer shell of this species consists of the inner, middle and outermost shell layers, and the colour markings are confined to the surface of the outermost one. As the ventral part of this specimen is coated with host rock, or the outermost shell layer in this region has been secondarily exfoliated, the colour markings are restricted to the outermost layer near the umbilicus and on the inner flank. The surface of the outermost shell layer is characterized by a finger-print-like ornamentation, and the traces of colour pattern take the form of dark brown radial stripes on a light brown ground. An enlarged drawing of the colour markings is shown in Text-fig. 2. The radial stripes are composed of primary and secondary ones, and each stripe is gently curved adorally, with a regular spacing of about 15 primaries per half revolution.

The primaries are narrow and weak on the umbilical wall, but tend to be broader towards the umbilical shoulder. Most of them bi- or trifurcate on the inner flank, and in this area one or more secondaries occasionally intercalate between two primaries. It is worthy of notice that each radial stripe has a serrated margin, similar to those seen in living *Nautilus* (Text-fig. 3).

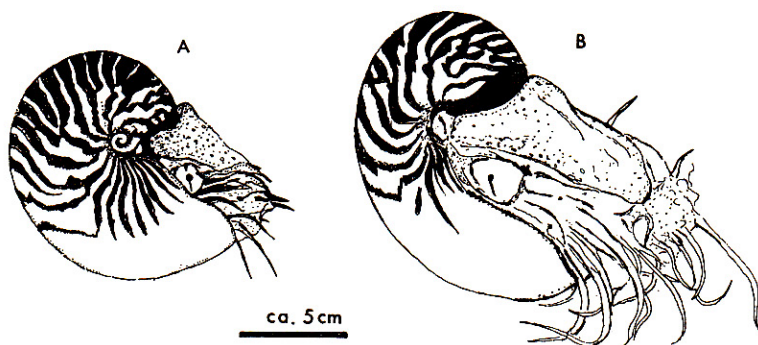


Fig. 3. Drawing of colour patterns in living *Nautilus*. A: *N. macromphalus* SOWERBY B: *N. pompilius* LINNÉ.

Measurements in mm:

	Diameter	Whorl breadth (wb)	Whorl height (wh)	wb/wh	Umbilicus
at	52.8	—	20.0	—	9.4
at	30.0	14.7	14.6	1.00	7.5

Remarks: The present species resembles *Tetragonites subtimotheanus* WIEDMANN (1962, pp. 131, 172) from the Upper Albian of British Columbia, Alaska (Chitina Valley) and Oregon (WIEDMANN, 1973), and from the Albian to the Lower Cenomanian of Europe (WIEDMANN, 1962), Madagascar (COLLIGNON, 1963), southern India (STOLICZKA, 1865) and Zululand (KENNEDY & KILNGER, 1977) in the mode of involution and presence of strong constrictions, but the former species has more compressed whorls. In this paper the writers tentatively treat it under *Tetragonites* sp.

2. *Tetragonites glabrus* (JIMBO) (Pl. 1, Figs. 2a-b)

Material: Kyushu University registered number (GK. H) 5871 from Loc. R 2665a, lower course of the Jugosenzawa, a tributary of the Obirashibe River (Lower Santonian).

Description: The colour marking in this species is confined to the outermost shell layer with "finger-print" surface ornamentation as in *Tetragonites* sp. already described. It takes the form of a longitudinal dark brown stripe on a light brown ground, presented on the flank from the 5th to the 6th whorls, and is thus quite different from the radial stripes in *T.* sp.

The longitudinal stripe can be traced on the inner flank, and the ratio of stripe width to whorl height is about 0.2, being constant with growth.

It is unclear whether the number of longitudinal stripes in this species are more than two or not, because of the unfavourable preservation of outermost shell layer on the middle flank and on the venter of the specimen.

Discussion

Most of the previously described colour markings in ammonoids are in the form of longitudinal bands; radial stripes have been noticed only in *Pleuroceras spinatum* (BRUGUIÈRE) from the Jurassic of Europe (SCHINDEWOLF, 1928, p. 137, fig. 1) and *Owenites koeneni* HYATT et SMITH from the Triassic of North America (TOZER, 1972, p. 126, fig. 3). Therefore, the colour marking in *Tetragonites* sp. is the third example with radial stripes.

According to previous reports, longitudinal stripes in ammonoids may be divided into those with one or more dark stripes on a light coloured ground (*Amaltheus*, *Androgynoceras*, *Tragophylloceras*, *Protexanites*; SPATH, 1935; ARKELL, 1957; PINNA, 1972; MATSUMOTO & HIRANO, 1976, respectively) and those with of one or more light coloured stripes on a dark ground (*Leioceras*, *Asteroceras*; GREPPIN, 1898; ARKELL, 1957, respectively). It goes without saying

that the colour markings of fossil ammonoids may not represent the original colour patterns in life, but the colour markings in the present two tetragonitid species belong to the former case.

It is well-known that various kinds of colour patterns on the outer shell surface of many living molluscs are of an hereditary nature. Some of them may be functional, but in some cases they may have no functional significance (SEILACHER, 1972). Indeed, some workers believe that the brownish to reddish flame colour patterns on the white outer shell surface in living *Nautilus* may have functioned as camouflage (COWEN *et al.*, 1973; KENNEDY & COBBAN, 1976; MATSUMOTO & HIRANO, 1976).

As stated previously, the present two species have the "finger-print" structure on the outermost shell layer with the trace of colour marking. A similar structure has been recognized in some well-preserved ammonites from Europe, and the outermost shell layer with "finger-print" structure is termed the wrinkle-layer (HOUSE, 1971; TOZER, 1972) or Runzelschicht (WALLISER, 1970).

According to TOZER, the wrinkle-layer is restricted to the Goniatitida and the Ceratitida, and little is known of the occurrence in the Phylloceratina, Lytoceratina and Ammonitina. However, an outermost shell layer similar to the wrinkle-layer of TOZER was reported in the Jurassic Graphoceratidae by SENIOR (1971); further microstructural examinations of outermost shell layers in many Mesozoic and Paleozoic ammonoids are required to resolve the above-mentioned problem.

Summary

Colour markings are preserved on the outermost shell layer of two specimens of tetragonitid ammonites, *Tetragonites* sp. and *Tetragonites glabrus* (JIMBO) which were collected respectively from the Lower Turonian and the Lower Santonian of the Obira area, northwestern Hokkaido. *T.* sp. has brownish serrate radial stripes on the light ground of the inner flank and the umbilical wall which are similar to the colour patterns of living *Nautilus*.

T. glabrus has a dark brownish longitudinal stripe on the light brownish inner flank.

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Explanation of plate 1

Figs. 1a-b. *Tetragnostes* sp. with serrate radial colour stripes on the inner flank and umbilical area. Kyushu University specimen (registered number, GK. H. 5870) from locality R 5211c, the upper stream of the Obirashibe River, Obira area, northwestern Hokkaido.

1a. Right side view. $\times 1$.

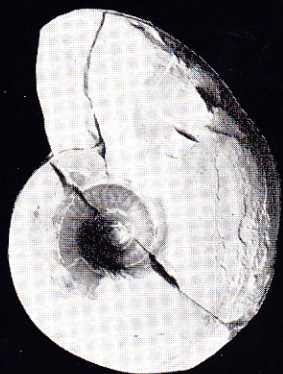
1b. Right side view. $\times 2$.

Figs. 2a-b. *Tetragnostes glabrus* (JIMBO) with a longitudinal colour stripe on the inner flank. Kyushu University specimen (GK. H. 5871) from locality R 2665a, the lower stream of the Jugosenzawa, a tributary of the Obirashibe River, Obira area.

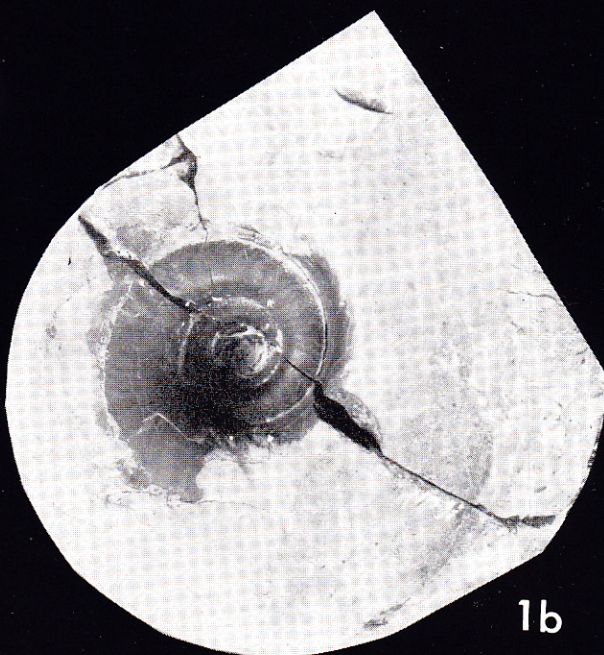
2a. Left side view. $\times 1$.

2b. Left umbilical side view. $\times 1.5$.

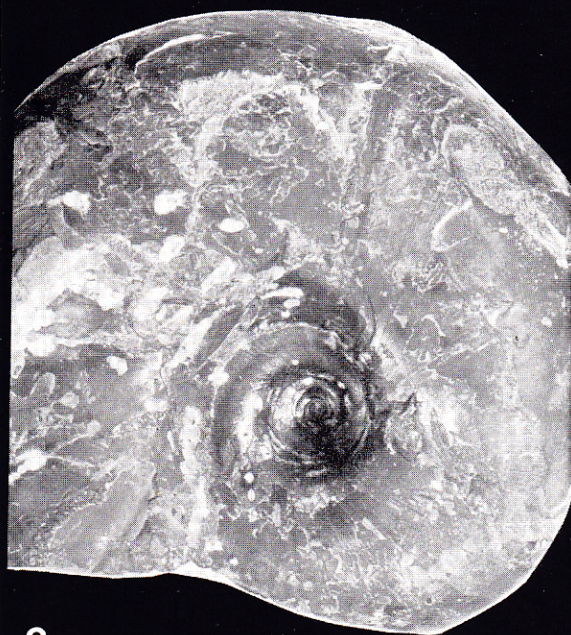
Photos, without whitening, by TANABE.



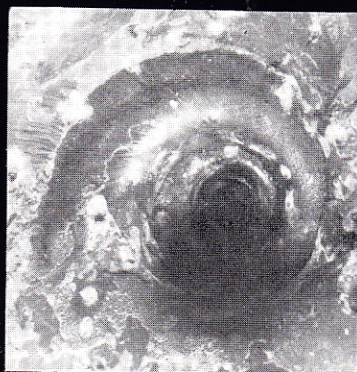
1a



1b



2a



2b