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Newly Collected Jurassic Ammonites from the Mansalay Formation, Mindoro Island, Philippines

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Abstract Four species of Jurassic ammonites, newly discovered from the Mansalay area in Oriental Mindoro, Philippines, are described and figured herein. Described are *Physodoceras* cf. *gortanii* and *Perisphinctes* (*Liosphinctes*) sp. from the Amaga River valley near Mansalay, and *Perispinctes* (*Liosphinctes*) cf. *laevipickeringius* and an unidentifiable Perisphinctid from Colasi Point south of Mansalay. This assemblage is indicative of middle Oxfordian age as a whole, in concordance with the correlation previously proposed. It indicates an obviously close affinity with the Tethys–Pacific faunas.

Key words: Ammonites, Jurassic, Mansalay Formation, Oriental Mindioro, Oxfordian, Philippines

Introduction

Mesozoic and older fossils are rare in the Philippines. According to Teves (1953), Jurassic ammonites were first discovered from the island of Mindoro by De Villa in 1940, who published his discovery in 1941. Around the same time, ammonites were collected by members of the then National Development Company from the same area (Corby *et al.*, 1951). Feliciano and Basco (1947) also reported the existence of Jurassic ammonites from around Mansalay. These ammonites were all collected from the Mansalay Formation (cf. Mines and Geosciences Bureau, 2010) which is exposed in the area around Mansalay in Oriental Mindoro Province. This area includes the coast south of Mansalay and drainage areas of the Mansalay and Bagacay Rivers flowing into Tablas Strait.

These Jurassic ammonites were listed in Teves (1953) and Rivera (1954). Although the lists include more than 20 species, none was described systematically. Systematic studies were not published until Sato (1961) and Sato (1968 in Andal *et al.*). The latter proposed three zones based on the ammonite assemblages, and the zones were recapitulated with modifications by Sato and Westermann (1991). Since then, it appears that no new knowledge on Jurassic ammonites was added. This is evident in the recent general geology book on the Philippine archipelago prepared by the Mines and Geosciences Bureau (2010).

Recently, some well-preserved specimens were collected from Colasi Point and the Amaga River valley in the Mansalay area. The fossil materials examined and discussed here were collected during the short-term field sampling con-

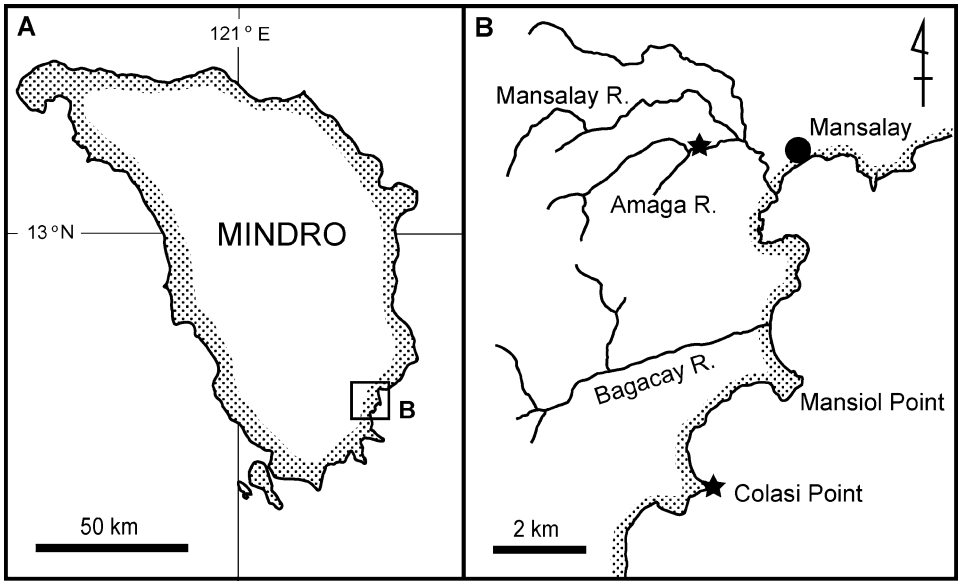

Fig. 1. Index map showing the localities (★) from which ammonoids were collected.

ducted by the National Museum, Philippines (NMP), Mines and Geosciences Bureau, Philippines (MGB) and the National Museum of Nature and Science, Tokyo (NMNS), in February 2010, on the basis of agreements between NMP and NMNS, and MGB and NMNS, respectively. The project aims at collecting standard fossil reference material in the Philippines, geared toward understanding the origin of high marine biodiversity in the Philippine archipelago. The fossil collection was undertaken in two field surveys, first by De Ocampo and Ong (NMP) in mid-February, 2010 and second by Aguilar, Mago (MGB) and Kase (NSMS) in late February, 2010. The specimens were prepared, photographed and examined preliminarily by Shigeta (NMNS), and studied systematically by Sato. This is the paleontological description of the new collection.

Localities of Ammonite Collection

The specimens described below were all collected from the area near Mansalay, Oriental Mindoro Province (Fig. 1). Mansalay is located on the southeastern coast of Mindoro Island, facing Tablas Strait between Tablas and Mindoro islands. Two river systems flow into this strait from the back range of Mansalay, the Mansalay River to the north and the Bagacay River to the south. Fossils are common in the Amaga River valley, a tributary of the Mansalay. Two of the present specimens [*Physodoceras* and *Perisphinctes* (*Liosphinctes*) sp.] were collected from floats on the Amaga River. To the south of Mansalay, Colasi Point protrudes to Tablas Strait, where the other two specimens [*Perisphinctes* (*Liosphinctes*) cf. *laevipickeringius* and Perisphinctid gen. et sp. indet.] were collected also from floats. Ammonite-bearing formations of all these localities belong to the Mansalay Formation.

Faunistic and Chronological Considerations

Identified and described here are two species of *Perisphinctes* (*Liosphinctes*), a species of *Physodoceras*, and an unidentifiable Perisphinctid. Subgenus *Liosphinctes* was created on an English species as the type species, and its geographical distribution covers England, Germany, Switzerland, France, Poland, Spain and Portugal. A species was illustrated from the Argovian (late middle Oxfordian) of Madagascar (Collignon, 1959). *Physodoceras* occurs widely in the Tethys

realm and its distribution extends to the East Coast of the Pacific Ocean, passing through the Himalayas. As a whole, the newly discovered faunule has a close affinity to the Tethys fauna, as indicated by the Mansalay fauna described earlier (Sato in Andal *et al.*, 1968).

The classical Jurassic ammonite fauna in the Sula Islands, Indonesia, including Taliabu and Mangoli Islands (Boehm, 1907), has Oxfordian elements. In general composition, this fauna is similar to the Mansalay fauna, as Aspidoceratids and Perisphinctids are included, but differs from the Mansalay fauna in detail. There is no common species (or genus) with the Philippine fauna.

It was previously claimed that the ammonites from the Mansalay Formation are distributed chronologically in three different horizons (Andal *et al.*, 1968). The upper two horizons are represented by *Euaspidoceras* cf. *hypselum* Assemblage Zone and *Taramelliceras* and *Parawedekindia arduennensis* Assemblage Zone. The former is correlated with late Cordatum to early Transversarium Zones (early and middle Oxfordian) and the latter with middle to late Oxfordian (Sato and Westermann, 1991). Newly discovered *P.* (*Liosphinctes*) suggests middle Oxfordian and *Physodoceras* late Oxfordian to early Kimmeridgian. Therefore there is no serious contradiction to the hitherto accepted correlation.

Systematic Description

(Family and subfamily classification adopted from Donovan *et al.*, 1981)

Superfamily Perisphinctoidea Steinmann, 1890

Family Perisphinctidae Steinmann, 1890

Subfamily Perisphinctinae Steinmann, 1890

Genus ***Perisphinctes*** Waagen, 1869

Subgenus ***Liosphinctes*** Buckman, 1925

Perisphinctes (***Liosphinctes***) cf. ***laevipickeringius*** (Arkell)

Fig. 2

cf. *Perisphinctes* (*Arisphinctes*) *laevipickeringius* Arkell, 1939, p. 143, Pl. XXX, Figs. 1–6, Plate XXII, Fig. 6.

cf. *Perisphinctes* (*Liosphinctes*) cf. *laevipickeringius* (Arkell), Enay, 1966, p. 420.

cf. *Perisphinctes laevipickeringius* (Arkell), Brochwicz-Lewinski, 1972, p. 488, Pl. 8, fig. 2.

Material: MGB-Amm 0001, wholly septate, thus immature shell, extracted from a float of calcareous concretion at Colasi Point, near Mansalay, Oriental Mindoro, by T. Kase, Y. M. Aguilar and W. Mago.

Measurements: Taken at D = 293 mm of MGB-Amm 0001, UD = 143 mm, H = 40 mm, W unknown, UD/D = 0.49. Number of ribs is 26 per last half whorl and 32 per preceding half whorl.

Description: Serpenticone with rather evolute coiling (UD/D about 0.49). Whorl section rounded quadrate, higher than wide, flanks flat on the inner whorls but slightly convex on the last whorl. Umbilicus wide and open. Umbilical wall nearly vertical with rounded border. Venter broadly arched, without furrow. Constrictions present, running parallel to ribbing, three or four per whorl, broad and shallow but not prominent as in typical perisphinctids. Ribbing of perisphinctid type; on the inner whorls, ribs dense and fine, slightly prorsiradiate, but become gradually coarser and distant as growing whorls; on the last preserved whorl primary ribs rectiradiate and slightly prorsiradiate on the flanks, after initial twist at the umbilical margin; on the last preserved whorl primary ribs become blunt swells on the flanks, then vaguely trifurcate or fasciculate at the ventral border and tend to fade away on the venter. Suture-line not clearly visible.

Observation: This is an incomplete specimen; only one side of the shell is preserved as the inner mold. The living chamber is lost. This condition precludes detailed observation of the morphology of the whole shell. It is, however, clearly observable that the whorls are more or less evolute (UD/D about 0.5), and the growth rate is relatively high. As the umbilical wall is vertical and well defined with sharp umbilical border, the umbilical area is well defined. Because the inner whorls are only partly observable in the umbilicus and are somewhat corroded, their general

Fig. 2. *Perisphinctes* (*Liosphinctes*) cf. *laevipickeringius* (Arkell, 1939), MGB-Amm 0001, from a float of calcareous concretion found at Colasi Point, Mansalay, Oriental Mindoro, Philippines. **1**, Right lateral view. **2**, Ventral view. Scale bar = 50 mm.

features are hardly confirmed. As observed on the whorls in the umbilicus, the ribs on the flanks are fine and dense, but the type of branching is not clear as the outer flank is concealed by the succeeding whorl. The ventral region is not completely observable either; therefore the specimen's exact morphology is not known in detail. The number of ribs changes following the development: on the inner whorls, primary ribs number about 60 per whorl or less (at the shell diameter of about 220 mm), while on the outer whorls, primary ribs number about 50 (at the diameter of about 290 mm). The change of ribbing seems to occur gradually; however, this cannot be concluded with certainty because the transitional part is broken.

Comparisons and affinities: The classification of Perisphinctidae is confusing. Here we adopt the classification of Donovan *et al.* (1981), but there are different views about the subfamily-level classification. Oxfordian perisphinctids are, above all, very confusing. *Liosphinctes* was

established in 1925 by Buckman, who gave neither written description nor diagnosis but cited only a short note on the figure (Type Ammonites, Vol. V, Pl. DLXVI, 1925). Later Arkell (1939, p. lviii) described generic characters essentially based on the holotype. He pointed out a close affinity with *Arisphinctes*, but accepted its subgeneric rank under the prolific genus *Perisphinctes*, after some reservation. He retained this classification in the Treatise on Invertebrate Paleontology, Part L (Arkell *et al.*, 1957, p. L322). By now, this classification has been accepted most widely; to cite examples, Enay (1966), Schlampp (1991) and Gygi (2001) among others.

On the other hand, some authors believe that *Liosphinctes* should be of generic rank, as advocated by Brochwicz-Lewinski (1972), Callomon (1960), Glowniak (2002), Glowniak and Wierzbowski (2007), and so on.

In fact, *Liosphinctes* shows gradual morphological transition to other genera, such as *Arisphinctes*; that makes distinction of two genera not easy. Many authors proposed the synonymy of *Liosphinctes* with other genera, for instance Geyer (1961) considered that *Liosphinctes* is synonymous with *Kranaosphinctes*, as did Glowniak (2002). Glowniak and Wierzbowski (2007) thought that *Decipia*, *Platysphinctes* and *Progeronia* as junior synonyms of *Liosphinctes*. In fact, these three genera are very similar in morphology and difficult to distinguish, especially when specimens are not well preserved.

Here, as the result of searching the species ascribed to this subgenus in the literature available, it is concluded that the present specimen, though not complete, shows a close affinity with *P*. (*L*.) *laevipickeringius*, described first by Arkell (1939) from Oxfordshire, England. This species shows rather common characteristics with the Amaga specimen; rather fast growth, gradual modification of ribbing during the development, fine dense ribbing on the inner whorls and bulging primary ribs on the more grown whorls, besides others. Here, this is described as *P*. (*L*.) cf. *pickeringius*.

Occurrence: Colasi Point, south of Mansalay, Oriental Minodoro, Philippines.

Geological age: Middle Oxfordian.

Geologic formation: Mansalay Formation.

***Perisphinctes* (*Liosphinctes*) sp.**

Fig. 3

Material: NMP-1089, a broken specimen collected from a float of calcareous concretion in the Amaga River, near Mansalay, Oriental Mindoro, by R. De Campo and P. A. Ong.

Measurements: Taken at D = ca. 150 mm of NMP-1089, UD = 70 mm, H = 55 mm, W unknown, UD/D = 0.46. Number of primary ribs is 56 per whorl at D = ca. 100 mm.

Description: Serpenticone with coiling more or less involute (UD/D about 0.46); whorl section rounded quadrate, higher than wide; growth rate high; umbilicus open and shallow with well-defined umbilical wall and rounded border. Ribbing on inner whorls fine, dense (number of primaries about 70 at D = ca. 90 mm), slightly prorsiradiate, and bifurcate with sharp angles at outer flanks, simple ribs rarely inserted; ribs gradually thicker on the last part of phragmocone, then on the last whorls primaries becoming coarse, rectiradiate, and generally fasciculate with somewhat finer secondaries, which pass over ventral region without interruption. Suture-line not clearly observable.

Observation: The studied specimen is partly broken, consisting of a part of the last whorl (living chamber) and inner whorls the last part of which are broken and lost. The ribbing changes gradually from fine, dense and rectiradiate on the inner whorls to coarser radial on the outer whorls, but this transition cannot be confirmed because the part of transition is lost.

The first part of the preserved last whorl is still septate, indicating that most part of the last preserved whorl is the living chamber. Ribbing on this part is composed of distant and coarse primary ribs and more numerous but less prominent secondaries, which are given rise from the primaries by obscure fasciculation. Many of the sec-

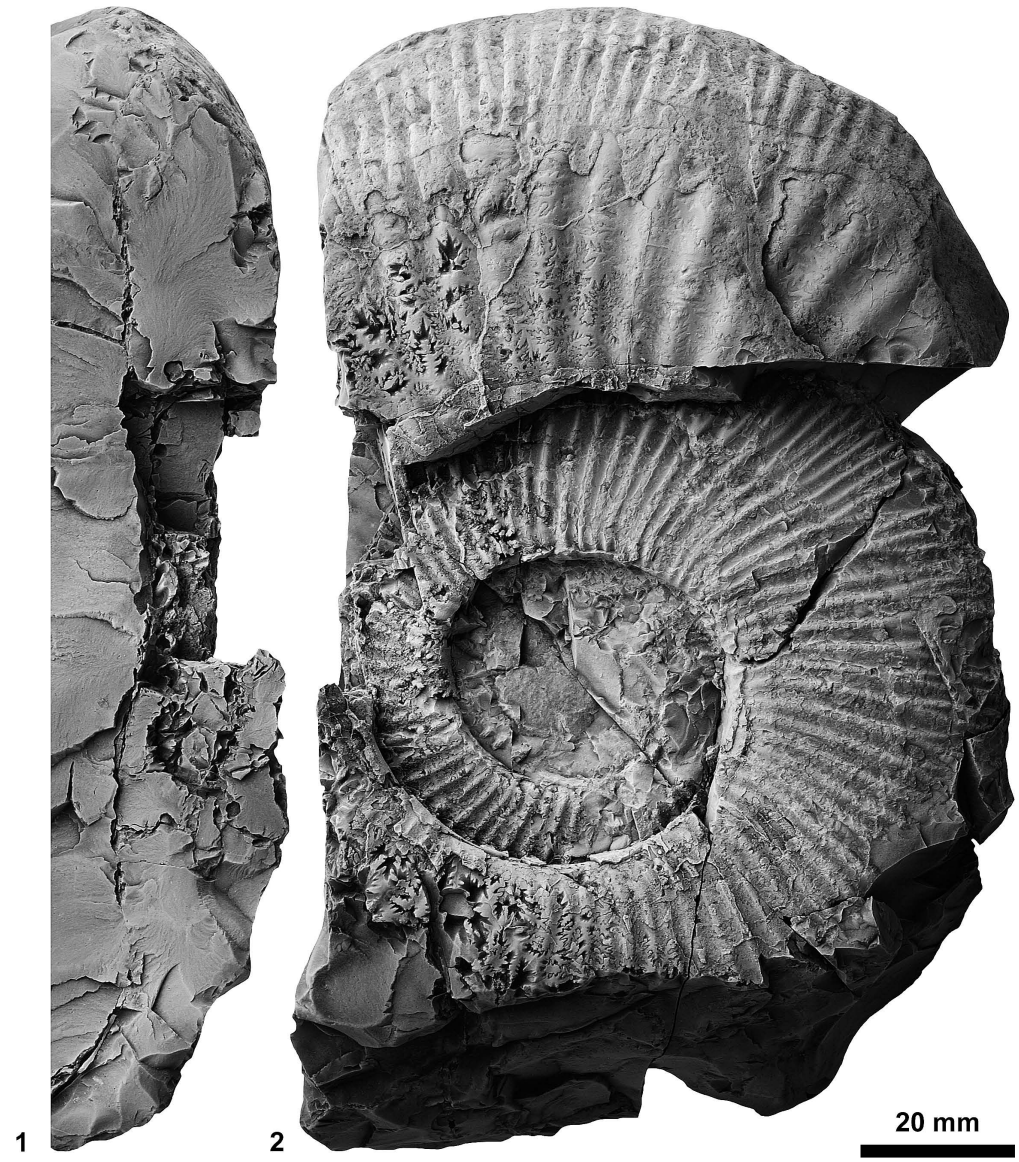

Fig. 3. *Perisphinctes* (*Liosphinctes*) sp. indet., NMP-1089, from a float of calcareous concretion found in the Amaga River, Mansalay, Oriental Mindoro, Philippines. **1**, Ventral view. **2**, Left lateral view. Scale bar = 20 mm.

ondaries are free, ending at the outer flanks. Suture-lines are partly observable, showing oblique umbilical lobes, deeply incised, undoubtedly of perisphinctid type.

Comparisons and Affinities: Because the specimen is incomplete, without the living chamber, any definitive identification is impossible. The ribbing on the inner whorls (at D = ca. 140 mm) is similar to that of *P.* (*L.*) cf. *laevipickeringius* described above. The basic characters, such as fine dense ribbing in the young stage, gradually changing to more distant, coarse obtuse ribbing, indicate that the specimen belongs also to *Liosphinctes,* but is likely to differ from *P.* (*L.*) cf. *laevipickeringius* by more involute coiling and finer and denser ribbing.

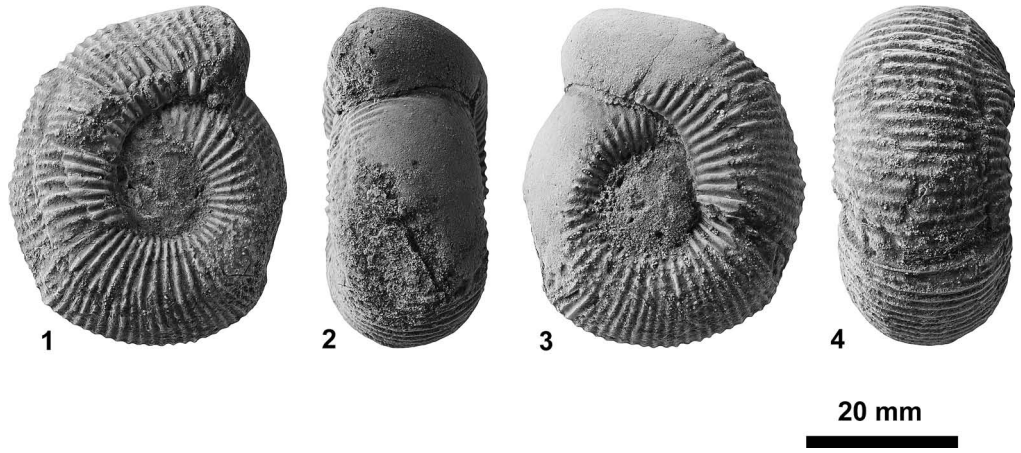

Fig. 4. Perisphinctidae gen. et sp. indet., NMP-1078, from a float of calcareous concretion found in the Amaga River, Mansalay, Oriental Mindoro, Philippines. **1**, Left lateral view, **2**, Ventral view of the younger half of the preserved last whorl, **3**, Right lateral view, **4**, Ventral view of the last half of the last whorl. Scale bar = 20 mm.

Occurrence: Amaga River valley (float) in the Mansalay area, Oriental Mindoro.

Geologic age: Most likely middle Oxfordian, as suggested by accompanying *P.* (*L.*) cf. *laevipickeringius* and *Physodoceras* cf. *gortanii*, both described herein.

Geological formation: Mansalay Formation.

Perisphinctidae gen. et sp. indet.

Fig. 4

Material: NMP-1078, well-preserved small specimen, probably immature, collected from a float of calcareous concretion at Colasi Point, near Mansalay, Oriental Mindoro, by R. De Campo and P. A. Ong.

Measurement: Taken at D = 45 mm of NMP-1078, UD = 16 mm, H = 15 mm, W unknown, UD/D = 0.31.

Description: A small involute sphaerocone with retracted body chamber. Umbilicus shallow and elliptical, with rounded border. Whorl section depressed circular, much wider than high; flanks and venter broadly rounded. Two or three constrictions parallel to ribbing. Ribbing invariably fine on all parts, sharply bifurcated at the ventro-lateral shoulder, passing over ventral region without interruption or inflection. Suture-line not observable.

Observation: This is a small specimen, impossible to judge whether this is an adult or not, because the last part of the preserved whorl is incomplete. The preserved last part is retracted, showing remarkably eccentric coiling, but the possibility of later deformation is not excluded. Generally the cross section of whorls is quite depressed, much thicker than high; however, this may be a result of later deformation.

Ribbing is always sharp, fine and dense; primary ribs start from the umbilical suture, and rectiradiate on the flanks; they are mostly bifurcate at the ventro-lateral shoulder to the secondary ribs of the same strength as the primaries, passing through ventral region without interruption; simple ribs are sometimes inserted on the outer flanks.

Remarks: As the specimen is incomplete, any reliable determination is impossible. Due to the style of ribbing and coiling, this is tentatively referred as juvenile whorls of a perisphinctid.

Occurrence: Colasi Point (float).

Geological age: Uncertain.

Geological formation: Mansalay Formation.

Family Aspidoceratidae Zittel, 1895

Subfamily Aspidoceratinae Zittel, 1895

Genus ***Physodoceras*** Hyatt, 1900

Physodoceras cf. ***gortanii*** (Venzo)

Figs. 5, 6

cf. 1942 *Aspidoceras gortanii*, Venzo, p. 63, Pl. XI, Fig. 1a–c.

cf. 1959 *Physodoceras gortanii*, Venzo, p.73, Pl. XI, Fig. 1a–c.

Material: NMNS PM23456, a specimen incomplete, one side well preserved while the other deeply corroded; collected from a float of calcareous concretion in the Amaga River, near Mansalay, Oriental Mindoro, by W. Mago.

Measurements: Taken at D = ca. 117 mm of NMNS PM23456, UD = 30 mm, H = 55 mm, W = ca. 50, UD/D = 0.25.

Description: Shell globular with involute coiling (UD/D about one fourth). Whorl section rounded mushroom-like, slightly higher than wide, widest at the lower third of flanks. Umbilicus narrow and deep, with vertical umbilical wall and well defined but rounded border. Ornamentation generally poor, almost smooth except fine striae. A single row of rounded tubercles at the umbilical border. Some tubercles elongated radially, merging with obscure radial swellings on the flanks. No suture-line visible.

Observation: The material for study is a phragmocone, totally septate, as clearly seen on the corroded side, on which more than 10 septa are observable. Whorls are somewhat crushed, and the surface is more or less corroded. The general shape of the preserved whorls is recognizable, and the cross section of the whorl can be traced (Fig. 6) which is elliptical in shape, with a rounded ventral region, and a well-defined umbilical wall especially on the inner whorls. The ventral region is also rounded without any keels or furrows. Flanks are convex and almost smooth, but probably covered with fine striae (perhaps growth lines) as seen locally. A row of tubercles (or spines) is at the umbilical border, but the tubercles themselves are broken off, leaving only circular cross sections on the whorl surface. The elongation direction of the tubercles is thus not known. It is not decided whether the tubercles protrude perpendicularly to the flanks or toward the center of the umbilicus (important criteria for *Physodoceras*). There is no evidence of a mid-flank row of tubercles. Tubercles number 12 or so per whorl. Inner whorls are partly seen in the umbilicus. Peri-umbilical tubercles are seen but not as clearly as in the last whorls preserved. Obtuse ribs or swellings connecting to the tubercles are also partly visible, as are fine striae on the shell surface. Inner whorls have somewhat regular ribs.

Comparisons and affinities: Poor state of preservation precludes definite determination, but the globular form of the shell with a single row of peri-umbilical tubercles suggests that this specimen belongs to either *Aspidoceras* or *Physodoceras*. Generally the genus *Aspidoceras* is characterized by two rows of tubercles, one at the umbilical border and the other at the middle of the flanks, but there are some forms with only a single row of tubercles on adult whorls, such as *Aspidoceras uninodosum* Toula (1907). However, this last species has bituberculate immature whorls, and the outer row tends to disappear on adult whorls. This character is not ascertained on the present specimen.

On the other hand, a single row of tubercles is the distinctive character of *Physodoceras* Hyatt, in which the row is situated on the umbilical border and the tubercles, or spines, are directed to the center of the umbilicus. A row of tubercles is at the umbilical border on the present specimen and no tubercles are observable on the flanks, at least on the preserved whorls. Unfortunately, because the tubercles (or spines) themselves were not preserved, leaving only circular basal sections on the shell, the direction of the spines cannot be confirmed.

Numerous species are attributed to this genus, but most of them are different except a few, namely *Physodoceras gortanii* (Venzo) and *Ph.*

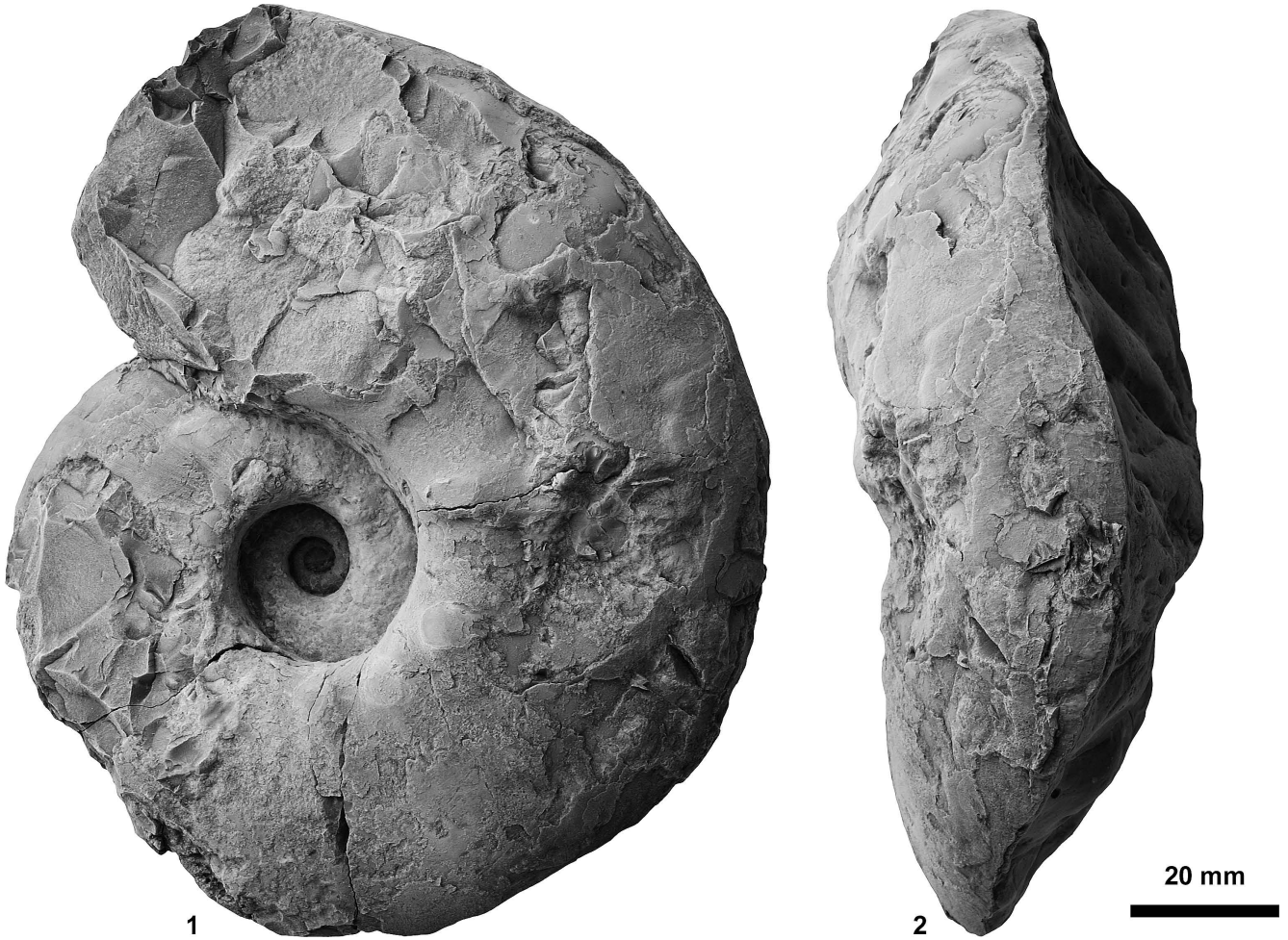

Fig. 5. *Physodoceras* cf. *gortanii* (Venzo, 1942), NMNS PM23456, from a float of calcareous concretion found at Colasi Point, Mansalay, Oriental Mindoro, Philippines. **1**, Right lateral view. **2**, Ventral view. Scale bar = 20 mm.

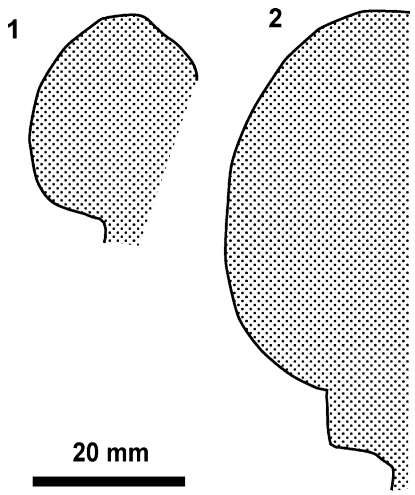

Fig. 6. Cross sections of *Physodoceras* cf. *gortanii* (Venzo, 1942), NMNS PM23456, at whorl height of 28 mm (1) and 51 mm (2).

wolfi (Neumayr). The original figure of *Ph. wolfi* (Neumayr, 1873, Pl.38, Fig. 4) shows a very smooth shell surface, but this figure has likely been retouched. Other specimens which Checa (1985) illustrated under the same name bear faint but distinct peri-umbilical tubercles, which seem to be somewhat comma-like, and are not identical with the present form. *Physodoceras gortanii* (Venzo), at first attributed to *Aspidoceras* (Venzo, 1942, p. 63), later changed to *Physodoceras gortanii* (Venzo, 1959, p. 73), is much like the present specimen, having similar involution, vertical umbilical wall, rounded umbilical border and much more prominent tubercles (though broken).

In conclusion, this form is referred to *Physodoceras gortanii*, though the definite generic identification is difficult. It should be noted that the distinction between *Physodoceras* and unituberculate *Aspidoceras* is extremely difficult.

Geological age: *Physodoceras* occurs, according to Checa (1985), in the time interval from upper Oxfordian to lower Kimmeridgian inclusive, at least in Europe. There are some other reports that the genus occurs even in upper Kimmeridgian. Because the present specimen was collected from a float of the Amaga River, its stratigraphic horizon is not determined in detail. However, there would be no contradiction with the known age (Amaga River Horizon and upper, Andal *et al.*, 1968) of Oxfordian (Sato and Westermann, 1991).

Occurrence: Amaga River, a tributary of the Mansalay River, Mansalay, Oriental Mindoro.

Geological formation: Probably upper part of the Mansalay Formation.

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