A new fossiliferous site of Lower Liassic (Upper Sinemurian) marine sediments from the southern Sierra Madre Oriental (Puebla, Mexico): ammonite fauna, biostratigraphy, and description of *Ectocentrites hillebrandti* new species

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ABSTRACT

We describe ammonites from a newly discovered, fossil-bearing, marine Liassic locality (Lower Jurassic, Huayacocotla Fm.) in the vicinity of the Zongozotla Municipality (southern Sierra Madre Oriental) in the northern part of Puebla State (Mexico). The fossiliferous strata are about 1 m in thickness and yield ammonites and bivalves. The ammonites are Late Sinemurian in age and they represent a biohorizon which is correlated with the Paltechioceras gr. burckhardti horizon reported from the Tenango de Doria area. Ectocentrites hillebrandti n. sp. is described.

Key words: Ammonites, Ectocentrites hillebrandti n. sp., Lower Jurassic, Upper Sinemurian, Puebla, Mexico.

RESUMEN

Se describen ammonites de una nueva localidad fosilífera Liásica marina (Jurásico Inferior, Fm. Huayacocotla) ubicada en las cercanías del Municipio de Zongozotla (Sur de la Sierra Madre Oriental) en la parte norte del Estado de Puebla (México). Las capas fosilíferas tienen un espesor de 1 m y contienen ammonites y bivalvos. Los ammonites tienen una edad Sinemuriano Tardío y representan un biohorizonte que puede ser correlacionado con el horizonte Paltechioceras gr. burckhardti previamente reportado para la región de Tenango de Doria. Se describe la nueva especie Ectocentrites hillebrandti n. sp.

Palabras clave: Ammonites, Ectocentrites hillebrandti n. sp., Jurásico Inferior, Sinemuriano Superior, Puebla, México.

INTRODUCTION

During field work in 2006 one of us (R. S.-E.) discovered a new site of fossil-bearing Lower Liassic marine sediments in the vicinity of Zongozotla Municipality in the northern part of Puebla State (Mexico, Figure 1). The geological map (1:50.000 Zacatlán sheet, E13-B14, Puebla, Servicio Geológico Mexicano, 1997) shows this area to be underlain by the Lower Jurassic Huayacocotla Formation. The locality was again sampled by R. S.-E. in 2007. The collected ammonite fauna allows correlation with already proposed biostratigraphic schemes (Meister *et al*., 2005, in press).

Liassic marine sediments crop out in the core-zone of the Sierra Madre Oriental in the Huayacocotla Anticline (*e.g.*, Schmidt-Effing, 1976, 1977, 1980). They can be

observed over a distance of about 200 km from the area of Tamazunchale (San Luis Potosí) in the NW to the Totolapa ravine in the vicinity of Huauchinango (Puebla, Figure 1b) in the SE. Farther to the SE, the marine Liassic sediments either dip below younger Mesozoic formations or are covered by Tertiary volcanics. On the occasion of road construction for a hydroelectric power plant, Flores (1967) discovered marine Liassic in the area of Mazatepec in the vicinity of Tezuitlán (Puebla). Presently, the latter outcrops are more or less inaccessible.

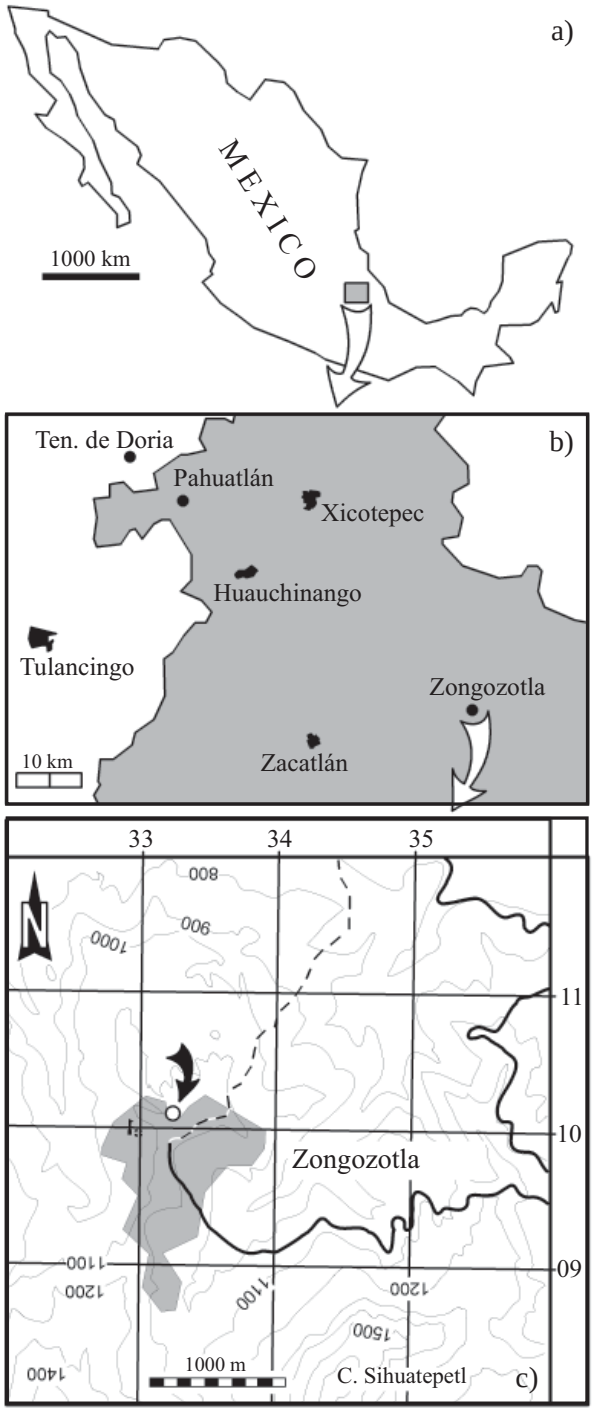

Figure 1. a-c: Location of the study area.

The newly found fossiliferous site at Zongozotla is part of the Huayacocotla Fm., forming the mountain ridge between 1000 and 1100 m in altitude directly to the north of the village (Figure 1c). This ridge is the continuation of the ridge bearing the village itself with an altitude between 900 and 1000 m. The sampled beds crop out over a length of about 100 m along a road cut close to the northern end of Zongozotla on the eastern flank of the mountain ridge. Bedding is horizontal. The outcropping rocks are well bedded and consist of alternating very fine grained claystone and siltstone. Due to their surface position, the sediments are bleached pale by weathering. The thickness of the fossil bearing series is about 1 m. So far, only this locality in the vicinity of Zongozotla has produced Liassic ammonites.

On the northern flank of the mountain ridge, comparable beds crop out along stairs leading uphill 20 m. These beds are more intensely weathered than those of the road cut. According to information provided by inhabitants of the houses in the vicinity, the outcropping series should yield ammonites. Nevertheless, none was found during fieldwork. Additional outcrops especially on the summit of the mountain ridge have not been seen.

SAMPLE DEPOSITION

All figured specimens are presently held in the Muséum d'Histoire Naturelle Genève (Département de Géologie et Paléontologie) and will be transferred to the National Paleontological Collection of the Museum of the Institute of Geology (IGM) at the UNAM. The IGM collection numbers are provided in the figure captions.

SYSTEMATIC PALAEONTOLOGY

Remark. All our material is crushed; therefore, our identifications are based on the lateral view of the shell.

Order Psiloceratida Houša, 1965
Superfamily Lytoceratoidea Neumayr, 1875
Family Pleuroacanthitidae Hyatt, 1900
(=Analytoceratidae Spath, 1927)
Subfamily Ectocentritinae Spath, 1926
Genus *Ectocentrites* Canavari, 1888

Type species. *Ammonites petersi* Hauer, 1856

***Ectocentrites hillebrandti* new species**
Figures 2a-c, 3a-f

Diagnosis. The species is charaterized by smooth inner whorls, an intermediate stage with ribs becoming strong and ending abruptly on the outer part of the flank, and a fine,

densely ribbed stage on the outer whorls. Constrictions are not developed throughout ontogeny.

Derivatio nominis. In honour of Prof. Dr. Axel von Hillebrandt for his major ammonite studies in South America.

Holotype. Specimen IGM 6220 illustrated in Figures 2a-b, 3f.

Type locality and stratum typicum. The ammonite horizon at Zongozotla village, Puebla, Mexico (Figure 1c).

Material. 10 specimens.

Description. Amongst our material, only the holotype shows the whole ontogeny of the species. All other specimens either are real juveniles or represent inner whorls. In none of our specimens the suture line is preserved.

The smooth initial stage prevails up to an umbilical width of about 10–12 mm. The length of the intermediate strong ribbed stage as well as the fine, densely ribbed adult stage can be observed only in the holotype. Due to bad preservation (*cf.* Figure 2a) we cannot measure exactly at which whorl diameter the change in the two ribbing stages occurs. We estimate an umbilical width of approximately 25 mm.

The last but two and three preserved ribs of the specimen in Figure 3b appear to end "tubercle-like". We interpret this as a diagenetic artefact due to shell crushing. A similar preservation of the ribs can be seen at the beginning of the outermost quarter whorl of the specimen in Figure 3e.

Comparison. The new species differs by its composite ontogeny from all other known small *Ectocentrites*. *E. dommerguesi* Meister, Khuc, Huyen and Doyle (2000) is finely and densely ribbed from a very early ontogenetic stage and shows constrictions. *E. leslei* (Taylor, Guex and Rakus, 2001) is the closest form but differs mainly by persistence of strong ribbing on the upper flanks of the outer whorls. The new species is a peramorphic form showing a short «*leslei*» ontogenetic stage and it develops a new ornamental character in the adult stage.

Local occurrence. The ammonite horizon at Zongozotla village, Puebla, Mexico (Figure 1c).

Age. ?Raricostatum Subzone (middle/upper part).

Geographical distribution. The species is known only from Mexico.

Superfamily Psiloceratoidea Hyatt, 1875
Family Oxynoticeratidae Hyatt, 1875
Genus *Gleviceras* Buckman, 1918

Type species. *Gleviceras glevense* Buckman, 1918 by original definition.

Remarks. The distinction between *Gleviceras* and *Oxynoticeras* based on crushed material is very ambiguous. Although the ranges of the two genera are well known in the Euroboreal domain (Dommergues *et al*., 1994), their

Figure 2. a-c: *Ectocentrites hillebrandti* n. sp. (a, b: IGM 6220, c: IGM 6217); a: holotype, b: detail of the inner whorls of the holotype. The arrow points to the strong ribs on the inner whorls representing the *E.* «*leslei*» ontogenetic stage; c: specimen showing the smooth initial and the strongly ribbed intermediate ontogenetic stages. The scale is for Figures a, c.

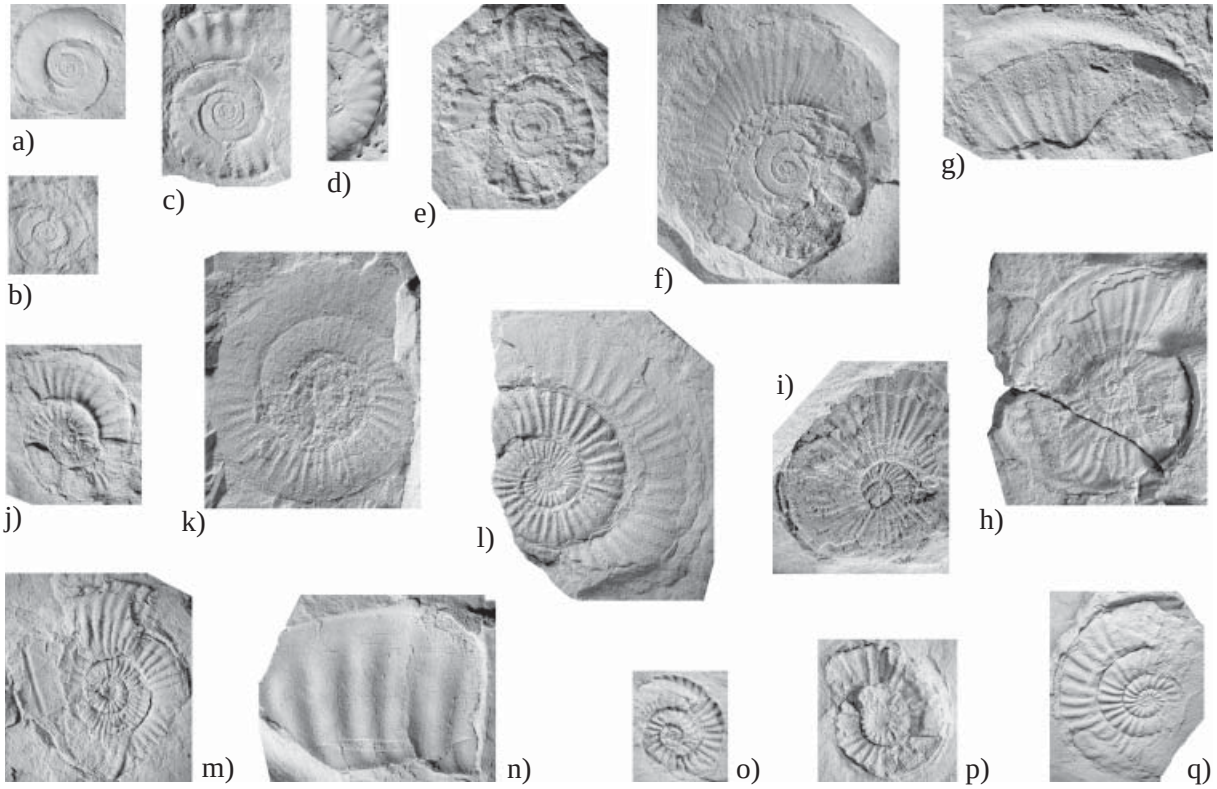

Figure 3. a-f: *Ectocentrites hillebrandti* n. sp. (a: IGM 6215, b: IGM 6216, c: IGM 6217, d: IGM 6218, e: IGM 6219, f: IGM 6220); a-b: «juvenile» specimens showing the initial smooth ontogenetic stage. c-e: specimens showing the smooth initial and the strongly ribbed intermediate ontogenetic stages. f: holotype, showing the complete ontogeny in rib morphology; g-i: *Gleviceras* aff. *palomense* (Erben, 1956) (g: IGM 6221, h: IGM 6222, i: IGM 6223); j-n: *Paltechioceras mexicanum* (Erben, 1956) (j: IGM 6224, k: IGM 6225, l: IGM 6226, m: IGM 6227, n: IGM 6228); o-q: *Paltechioceras* gr. *burckhardti* (Erben, 1956) (o: IGM 6229, p: IGM 6230, q: IGM 6231). All figures are in natural size.

ranges in the Pacific domain seem to be different based on associated ammonites. For example the association of *Gleviceras* with *Epophioceras, Asteroceras* and *Euerbenites* may indicate an earlier age there for *Gleviceras* (see Taylor *et al*., 2001).

Gleviceras aff. *palomense* (Erben, 1956)
Figure 3g-i

aff. * *Oxynoticeras* (*Radstockiceras*?) *palomense* Erben, 1956, p. 349, pl. 37, figs. 2-5.
aff. *Oxynoticeras palomense*; Meister, Blau, Schlatter and Schmidt-Effing, 2002, p. 398, pl. 3, figs. 5, 8-10.

Description. The three small specimens represent probably the inner whorls of *Gleviceras palomense* (Erben). The ribbing is dense and fine as in Erben's species. At this diameter the ribs are straight, slightly prorsiradiate and bend forward near the keel.

Material. 4 specimens.

Local occurrence. The ammonite horizon at Zongozotla village, Puebla, Mexico (Figure 1c).

Age. *Oxynoticeras palomense* Erben is known to be associated either with *Euerbenites* or with *Plesechioceras* from the Tenango de Doria area (Figure 1b) (Meister *et al.*, 2000). In Zongozotla, the species is associated with *Paltechioceras*. Therefore it spans a period from the top of the Obtusum Zone up to the middle/upper part of the Raricostatum Zone.

Geographical distribution. The species is known only from Mexico.

Family Echioceratidae Buckman, 1913
Genus *Paltechioceras* Buckman, 1924

Type species. *Paltechioceras elicitum* Buckman (1924) by original definition.

Paltechioceras mexicanum (Erben, 1956)
Figure 3j-n

* *Arnioceras ceratitoides* (Quenstedt) *mexicanum* Erben, 1956, p. 254, pl. 29, fig. 3 (holotype).

Description. Five specimens represent inner whorls which are characterized by straight and radial ribs and a relatively narrow umbilicus. The coiling and rib pattern fit well with that of the holotype. Two fragmentary specimens represent the outer whorls with quite strong and more widely spaced ribs, becoming smooth near the outer part.

Material. 7 specimens.

Comparison. In comparison to *P*. aff. *mexicanum* (Erben) *in* Blau *et al.* (2003, pl. 4, fig. 9) from the area of Tenango de Doria, the shell morphology is less evolute.
Local occurrence. The ammonite horizon at Zongozotla village, Puebla, Mexico (Figure 1c).
Age. ?Raricostatum Subzone (middle/upper part).
Geographical distribution. The species is known only from Mexico.

***Paltechioceras* gr. *burckhardti* (Erben, 1956)**
Figure 3o-q

* *Echioceras (Echioceras) burckhardti* Erben, 1956, p. 295, pl. 39, fig. 2.
Paltechioceras gr. *burckhardti*; Meister, Blau, Dommergues, Schlatter, Schmidt-Effing and Burk, 2005, p. 376, pl. 3, figs. 2-4, 6, 11, 12. (with synonymy).
Description. Our 3 specimens are characterized by quite strong ribs already on the innermost whorls. The specimens correspond well to the concept of *P. burckhardti* (Erben) as presented by Meister *et al.* (2005). According to these authors, the inner whorls of this small species show a great variability in rib density and rib strength while the outer whorls bear coarser and more widely spaced ribs. This concept comprises 11 species of Erben (1956) from the «*Echioceras burckhardti* unit» *sensu* Erben, including *P. burckhardti* (Erben). The three specimens from Zongozotla are close to the morphology of «*Echioceras (Echioceras) angustisulcatum* Erben».
Material. 3 specimens.
Local occurrence. The ammonite horizon at Zongozotla village, Puebla, Mexico (Figure 1c).
Age. ?Raricostatum Subzone (middle/upper part).
Geographical distribution. The species is known only from Mexico.

BIOSTRATIGRAPHY

For the first time, Early Jurassic ammonites are reported from the Zongozotla area in Mexico. The spatially nearest comparable Liassic fossiliferous sites are known from the NE (Totolapa gorge near Huauchinango, Figure 1b), and from Mazatepec (Flores, 1967) in the NNE.

The association of *P. mexicanum*, *P. burckhardti*, *G.* aff. *palomense* and *E. hillebrandti* can be easily correlated with the *P*. gr. *burckhardti* horizon described from the Tenango de Doria area (Meister *et al.*, 2005; in press). This horizon probably indicates the middle/upper Raricostatum Subzone (Raricostatum zone).

CONCLUSIONS

The new ammonite findings from the Huayacocotla Fm. show that field work can reveal additional information on the Lower Liassic ammonite biostratigraphy of Mexico. The already published ammonite zonations (Erben, 1956; Meister *et al*., 2005, in press) are based mainly on dispersed outcrops and therefore are synthetic. The search of new and continuous sections in not yet extensively investigated areas may expand our knowledge of Mexican Lower Liassic ammonite successions. The Mexican (Sierra Madre Oriental) Lower Jurassic probably is a key area connecting the North American (partly terrane bounded) and South American Early Jurassic ammonite «provinces».

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REFERENCES

Blau, J., Meister, C., Schlatter, R., Schmidt-Effing, R., 2003, Ammonites from the Lower Jurassic (Sinemurian) of Tenango de Doria (Sierra Madre Oriental, Mexico). Part III: Echioceratidae: Revue de Paléobiologie, 22(1), 421-437.

Buckman, S.S., 1909-1930, Yorkshire Type Ammonites, v. 3 Type Ammonites, parts 1-7: London, Weldon and Wesley, 709 pls.

Canavari, M., 1888, Contribuzione alla fauna de Lias inferiore di Spezia: Memorie Regio Comitato Geologico Italiano, 3, 57-227.

Dommergues, J.-L., Page, K.N., Meister, C., 1994, A detailed correlation of Upper Sinemurian (Lower Jurassic) ammonite biohorizons between Burgundy (France) and Britain: Newsletters on Stratigraphy, 30(2), 61-73.

Erben, H.K., 1956, El Jurásico Inferior de México y sus Amonitas, *in* 20. Congreso Geológico International: México, D. F., Universidad Nacional Autónoma de México, Instituto de Geología, xii + 393 p.

Flores-López, R., 1967, La fauna Liásica de Mazatepec, Puebla: Instituto Méxicano del Petróleo, Sección Geología, Monografía, 1, 25-30.

Hauer, F. von, 1856, Über die Cephalopoden aus dem Lias der nordöstlichen Alpen: Denkschriften der Akademie der Wissenschaften Wien, mathematisch-naturwissenschaftliche Classe, 11, 1-86.

Houša, V., 1965, Sexual dimorphism and the system of Jurassic and Cretaceous Ammonoidea (prelimanary note): Casopis národniho muzea, 134(7), 33-35.

Hyatt, A., 1875, Remarks on two new genera of Ammonites: *Agassiceras* and *Oxynoticeras*: Boston Society of Natural History, Proceedings, 17, 225-235.

Hyatt, A., 1900, Cephalopoda, *in* Zittel, K.A. von (ed.), Textbook of Palaeontology: London, Macmillan, 1st English edition, 502-604.

Meister, C., Khuc, V., Huyen, D.T., Doyle, P., 2000, Les ammonites et les bélemnites du Jurassique inférieur de Huu Niên, province de Quang Nam, Viêt Nam Central: Géobios, 33(1), 79-96.

Meister, C., Blau, J., Schlatter, R., Schmidt-Effing, R., 2002, Ammonites from the Lower Jurassic (Sinemurian) of Tenango de Doria (Sierra Madre Oriental, Mexico). Part II: Phylloceratoidea, Lytoceratoidea, Schlotheimiidae, Arietitinae, Oxynoticeratidae, and Eoderoceratidae: Revue de Paléobiologie, 21(1), 391-409.

Meister, C., Blau, J., Dommergues, J.-L., Schlatter, R., Schmidt-Effing, R., Burk, K., 2005, Ammonites from the Lower Jurassic (Sinemurian)

of Tenango de Doria (Sierra Madre Oriental, Mexico). Part IV: Biostratigraphy, Palaeobiogeography and taxonomic addendum: Revue de Paléobiologie, 24(1), 365-384.

Meister, C., Blau, J., Dommergues, J.-L., Schlatter, R., Schmidt-Effing, R., in press, Upper Sinemurian ammonite succession from the Sierra Madre Oriental (Mexico): Volumina Jurassica (Tomy Jurajskie).

Neumayr, M., 1875, Die Ammonitiden der Kreide und die Systematik der Ammonitiden: Zeitschrift der Deutschen Geologischen Gesellschaft, 27(4), 854-942.

Schmidt-Effing, R., 1976, Daten zur Entstehungsgeschichte von Golf, Karibik und Atlantik im Mesozoikum: Münstersche Forschungen zur Geologie und Paläontologie, 38/39, 201-217.

Schmidt-Effing, R., 1977, Der marine Unterjura Mexikos und seine Beziehung zur Entstehung des Golfes von Mexiko: Nachrichten der Deutschen Geologischen Gesellschaft, 17, 59-62.

Schmidt-Effing, R., 1980, The Huayacocotla aulacogen in Mexico (Lower Jurassic) and the origin of the Gulf of Mexico, *in* Pilger, R.H. (ed.), The origin of the Gulf of Mexico and the early opening of the central North Atlantic Ocean: Baton Rouge, Louisiana State University, 79-86.

Spath, L.F., 1926, Notes on Yorkshire ammonites: Naturalist, 1926, pp. 45-49, 137-140, 169-171, 201-206, 265-268.

Spath, L.F., 1927-1933, Revision of the Jurassic cephalopod faunas of Kachh (India): Palaeontographica Indica, 9/2, part 1, 1-945.

Servicio Geológico Mexicano, 1997, Geological map 1:50,000, Zacatlán sheet, E13-B14, Puebla: Pachuca, Hgo., Mexico, Servicio Geológico Mexicano, 1 map.

Taylor, D.G., Guex, J., Rakús, M., 2001, Hettangian and Sinemurian ammonoid zonation for the Western Cordillera of North America: Bulletin de la Société Vaudoise des Sciences Naturelles, 87(4), 381-405.

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