CHRONOLOGICAL AND GEOGRAPHICAL DISTRIBUTION OF THE FAM. COMELICANIIDAE MERLA, 1930 (BRACHIOPODA)

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Key - words: Brachiopods, Paleobiogeography, Chronostratigraphy, Upper Permian.

Riassunto. I Brachiopodi Comelicaniidi, fossili tipici del Permiano Superiore, sono stati considerati *markers* del Dorashamiano inferiore. Essi mostrano un'ampia distribuzione geografica che si estende dalle Alpi Meridionali (Italia) sino alla regione himalayana - Dolomiti e Carnia (Italia), Slovenia Centrale (Jugoslavia), M.ti Bükk e Area centro-danubiana (Ungheria), Transcaucasia (Armenia Sovietica, Nord Iran) e Spiti (Himalaya, India) - .

Ricerche stratigrafiche condotte sul limite Permo/Triassico delle Alpi Meridionali ed Ungheria mostrano che la distribuzione cronologica dei Comelicaniidi non è limitata, come precedentemente creduto, al Dorashamiano inferiore. Essi si distribuiscono dallo Dzhulfiano nei M.ti Bükk al Dorashamiano inferiore in Transcaucasia, sino ad un assai probabile Dorashamiano superiore nelle Alpi Meridionali e nell'Area centro- danubiana. In quest'ultime due zone una caratteristica associazione di *Comelicania* (*C.* gruppo *megalotis* e *C.* gruppo *ladina*) è situata in prossimità del limite P/T, in sezioni nelle quali il limite fra le formazioni permiane e triassiche viene considerato transizionale sia dal punto di vista litologico che paleontologico.

Il gen. *Spitispirifer* Waterhouse & Gupta, 1986 viene qui considerato sinonimo più recente di *Comelicania* Frech, 1901.

Abstract. The comelicaniid brachiopods, typical fossils of the Upper Permian, have been considered the markers for the Lower Dorashamian. They show a wide geographical distribution, that is from the Southern Alps (Italy) to Himalayan region - Dolomites and Carnia (Italy), Central Slovenia (Yugoslavia), Bükk Mts. and Transdanubian Central Range (Hungary), Transcaucasia (USSR Armenia and North Iran) and Spiti (Himalayas, India)-.

From stratigraphical researches carried out on the P/T boundary from the Southern Alps and Hungary, it has been found that the comelicaniid range is not restricted, as formerly supposed, to the Lower Dorashamian. The brachiopods span from Dzhulfian in the Bükk Mts., Lower Dorashamian in Transcaucasia, to a more likely Upper Dorashamian in the Southern Alps and Transdanubian Central Range. In these latter two localities a characteristic *Comelicania* assemblage (*C. megalotis* group and *C. ladina* group) occurs very close to the P/T boundary from sections in which the formational contact is considered transitional, both from lithological and paleontological points of view.

The gen. *Spitispirifer* Waterhouse & Gupta, 1986 from the Spiti section is here considered a junior synonym of *Comelicania* Frech, 1901.

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Introduction.

The articulate brachiopod *Comelicania* Frech, 1901 is one of more typical fossils of the Bellerophon Formation (Upper Permian) of the Southern Alps.

Until the 1960's it was considered an endemic form of South Tyrol, Comelico and Slovenia (Stache, 1878; Merla, 1930; Ramovs, 1958). The finding of *Comelicania triangularis* Grunt from the Transcaucasian ammonoid bearing sequences gave it a precise chronostratigraphical value (Ruzhentsev & Sarytcheva, 1965). It was considered a marker of Lower Dorashamian, after the institution of this stage (Rostovtsev & Azaryan, 1973).

Although *Comelicania* from the Southern Alps has been well known for over a century, with the institution of 11 species, its taxonomical position in the Family-group level has been uncertain until now. It depends on the fact that the internal features of the shells were neglected by the Old Authors.

Recently, Waterhouse & Gupta (1986) quote the occurrence of comelicaniids from the Spiti section (Himalayas). In this paper they give a brief taxonomical revision about these brachiopods creating three new genera (*Spitispirifer*, *Gruntallina*, and *Alatothyris*). According to the quoted Authors, these genera belong, with *Comelicania*, to the new Fam. *Comelicaniidae*. However, due to the lack in the literature of a detailed description of the internal features of *Comelicania* from South Tyrol, they base the *Comelicania* diagnosis on a drawing from Stache (1878), reaching an incorrect conclusion.

The stratigraphical setting of *Comelicania* from the Southern Alps was also unknown until a few years ago. Only recently it has been found that *Comelicania* beds are located at the top of the Bellerophon Fm., in a unit of 0.5 to 2 m thick, immediately below the Werfen Fm. (Neri & Posenato, 1985; Broglio Loriga et al., 1986 a,c).

Due to the high chronological value of *Comelicania* and the wide geographical distribution, a taxonomical revision of these brachiopods has become necessary. Thus, a systematic review, based on the type-collections and abundant new material is in progress by the present author.

Aim of this work is to give a picture of the geographical and chronological distribution of comelicaniids, in the light of the new findings from the Southern Alps, Hungary and the Himalayas. Moreover, some taxonomical remarks will be advanced to emend the *Comelicania* diagnosis given by Waterhouse & Gupta (1986).

Taxonomical remarks.

Order and Family-group.

In the Treatise on Invertebrate Paleontology (Moore (Ed.), 1965, p.H863), the taxonomical position -both Order and Family level- of *Comelicania* Frech, 1901 is uncertain.

Nevertheless Schuchert & Le Vene (1929) and Roger (1952) placed them in the Fam. *Athyridae* Phillips, Subfam. *Athyrinae* Waagen, while Merla (1930) created the new Subfam. *Comelicaniidae* (sic) belonging to Fam. *Spiriferidae* King.

Recently, Grunt (1986) put *Comelicania* in the Superfam. *Athyridacea* Davidson, Fam. *Spirigerellidae* Grunt, Subfam. *Spirigerellinae* Grunt, while Waterhouse & Gupta (1986) founded the Fam. *Comelicaniidae*, dubiously attributed to Superfam. *Athyridacea* Phillips, disregarding the subfamily created by Merla (1930).

The occurrence of a spiral brachidium both in the comelicaniids from Transcaucasia (Grunt, 1986) and the Southern Alps (personal observation) makes it possible to place them in the Order *Spiriferida* Waagen, according to the classification of Boucot et al. (in Moore (Ed.), 1965).

The position at Family-group level will be discussed when the taxonomical revision of comelicaniids is completed.

Some nomenclatural questions about the authorship of the Fam. *Comelicaniidae* are to be pointed out. If the Subfam. *Comelicaniinae* Merla, 1930 (*nomen correctum*, herein) is elevated to family rank, for ICZN (art. 10e, 23c, 50b), this taxon must also be attributed to Merla (1930). Nevertheless, as the name proposed by Merla (1930) has not been used for more than fifty years, it could be considered a *nomen oblitum* for ICZN (art. 23b). However, keeping in mind the stability of nomenclature, I attribute the family name to Merla (1930).

Genus.

Waterhouse & Gupta (1986), in the same paper where they described the comelicaniids from Spiti, give a short taxonomical review about these brachiopods. According to them, the following genera belong to the Fam. *Comelicaniidae* Waterhouse & Gupta:

- *Comelicania* Frech, 1901, type species *Spirifer (vultur) megalotis* Stache, 1878.
- *Alatothyris* Waterhouse & Gupta, 1986, type species *Spirifer (vultur) haueri* Stache, 1878.
- *Gruntallina* Waterhouse & Gupta, 1986, type species *Comelicania triangularis* Grunt, 1965.
- *Spitispirifer* Waterhouse & Gupta, 1986, type species *Spitispirifer bisulcatus* Waterhouse & Gupta, 1986.

The main features used by Waterhouse & Gupta to distinguish the genera are the structure of the cardinal process and shape of the shell. The quoted Authors base their *Comelicania* diagnosis on fig. 24b, pl. 2 of Stache (1878), since the description about the internal characters of these brachiopods from South Tyrol is lacking. The drawing of Stache illustrates ? *Spirifer (vultur) insanus* Stache, in which it seems that the cardinal process has two tubercles, as well as *C. triangularis* from Dorasham (Transcaucasia).

The comelicaniids from Spiti have the cardinal process bearing four tubercles, so they use the difference in the number of the tubercles to distinguish, at genus level, the Himalayan comelicaniids from the Tyrolian ones.

Among almost a hundred of *Comelicania* specimens collected in the South Tyrol and Venetian area, all the dorsal valves, in which the cardinal interior region is detectable, possess a cardinal process bearing four tubercles. The anterior pair is directed antero-ventrally, with the tubercles diverging from the cardinal plate and becoming distally flat or sharp. The posterior pair is dorsally recurved, culminating in parallel or dorsally converging lamellae (Fig. 1B, Cab). In the disarticulate dorsal valves the extremities of the tubercles are frequently broken and worn to varying degrees from the cardinal plate (Fig. 1A).

The features of the interior ventral valve from the Southern Alps are also very close to *Spitispirifer* as they are described and figured by Waterhouse & Gupta (1986). The delthyrium is open and internally delimited by low dental rims culminating with teeth, without any internal septum.

? *Spirifer (vultur) insanus* Stache figured by Stache (pl. 2, fig. 24a) is represented by a broken and incomplete specimen, lacking both the ears and the lateral regions of the shell. If the outline drawn by Stache (*op. cit.*), of the original shape, is correct, this speci-

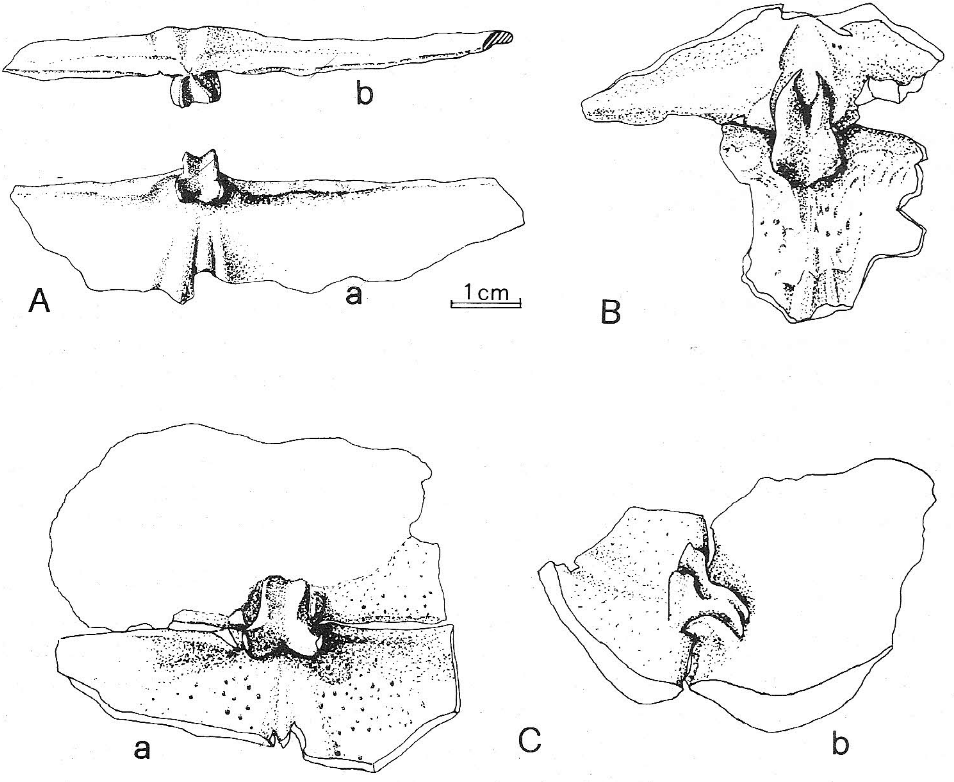

Fig. 1 - Cardinal processes of *Comelicania* from Southern Alps (x 1).
A) Isolated dorsal valve of *Comelicania* gr. *haueri* (Stache) from the Sass de Putia section (Bolzano). Interior (a) and posterior view (b).
B,C) Cardinal portions of two *Comelicania* gr. *megalotis* (Stache) specimens with divaricate valves from Valsugana (Trento).

men belongs to *C. ladina* group *sensu* Merla. Also the specimens belonging to this group of the present author's collection possess a cardinal process with four tubercles.

The position of view (posterior) of the specimen illustrated by Stache in fig. 24b does not permit us to distinguish if it bears two or four tubercles. In fact from this angle only the posterior pair is detectable and the slender posterior extremities are probably broken.

This is the situation of the specimen of Fig. 1A, in which from the posterior view it seems to bear only two tubercles (Fig. 1Ab), but from the internal view all four are detectable (Fig. 1Aa). This specimen is represented by an isolated dorsal valve with the extremities of the tubercles broken and worn.

Since *Spitispirifer* and *Comelicania* bear a cardinal process with four tubercles, the diagnostic character used by Waterhouse & Gupta (1986) to distinguish the two genera is not valid, so *Spitispirifer* must be considered a junior synonym of *Comelicania.* The moderate closeness in size and shape (Waterhouse & Gupta, 1986) of *Spitispirifer bisulcatus* with *C. megalotis* and *C. vultur* seems to indicate that only differences at species level exist, among the Southern Alpine and Himalayan comelicaniids.

Species.

The *Comelicania* species recorded from the Dolomites may be grouped, on the basis of shell shape, into three main morphogroups: *C. haueri* (Stache), *C. megalotis* (Stache) and *C. ladina* (Stache) *sensu* Merla, that is from strongly transverse to scarcely transverse shells (Pl. 50; Fig. 2).

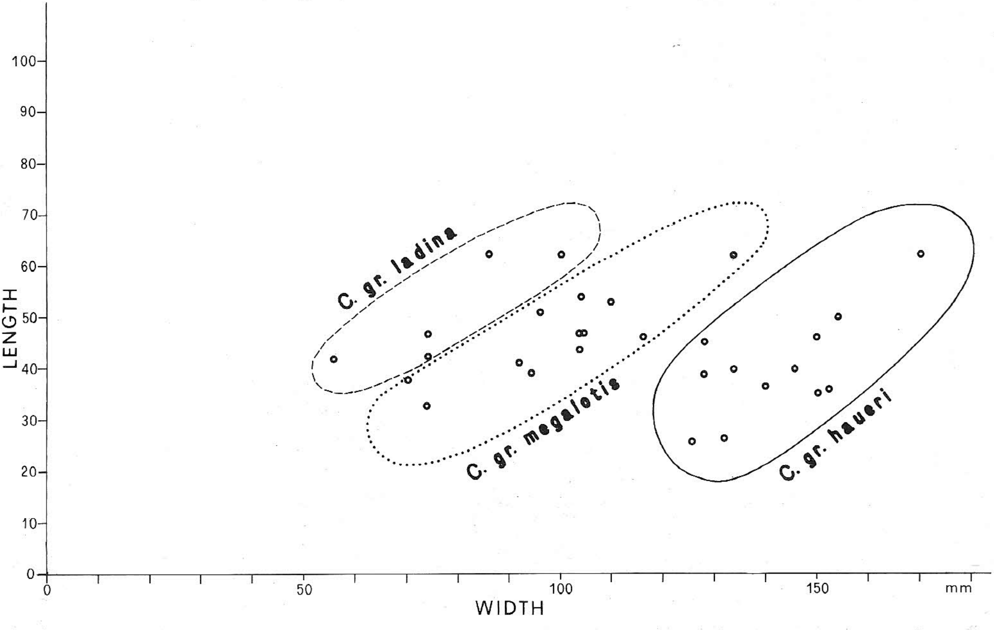

Fig. 2 - Scatter diagram of the pedicle valve measurements (in mm) of *Comelicania* species-groups from the Southern Alps.

- *C. haueri* group: large, strongly transverse and alate shells with very long and pointed ears gradually connected to anterior margin. L/W ratio= 0.20-0.36. Species: *C. haueri* (Stache), *C. dalpiazi* Merla, *C. macroptera* Merla, *C. avis* Merla, *C. vespertilio* Merla.
- *C. megalotis* group: large and transverse shells with ears well defined from the shell at the mature stage; inclination of lateral margins variable during onthogenetic development: straight and anteriorly converging in the juvenile stage (*C. haueri* group stage) to subparallel in the mature stage, anteriorly diverging in the senile stage. L/W ratio= 0.39-0.54. Species: *C. megalotis* (Stache), *C. vultur* (Stache), *C. doriphora* Merla, *C. rostrata* Merla.
- *C. ladina* group: moderately transverse shell, with short and pointed ears; width of the cardinal margin similar or a little greater than anterior ones. L/W ratio= 0.56-0.75. Species: *C. ladina* (Stache) *sensu* Merla, ? *C. insana* (Stache).

Comelicania is represented in the Southern Alps by large-size specimens, reaching 17 cm in width, in the *C. haueri* group (Tab. 1).

C. gr. *haueri*						*C.* gr. *megalotis*						*C.* gr. *ladina*					
		Wm	L	Lb	L/Wm			Wm	L	Lb	L/Wm			Wm	L	Lb	L/Wm
3	PB	140	37	32	0.26	1	PB	110	53	45	0.48	20	B	88	-	58	-
4	PB	150	36	?	0.24	21	P	104	47	-	0.45	47	P	86	62	-	0.72
5	P	132	27?	-	0.20	22	P	74?	33	-	0.44	49	B	90?	-	56	-
9	PB	128	39	?	0.30	25	PB	120	?	37?	-	50	B	106	-	57	-
19	PB	154	50	45	0.32	30	PB	94	39	33	0.41	52	P	56	42?	-	0.75
31	P	126	26?	-	0.20	46	PB	104?	54	45	0.51	65	PB	74?	47	?	0.63
41	PB	152	36	30	0.23	53	P	70?	38?	-	0.54	66	P	74	42	-	0.56
54	P	134	40	-	0.29	55	P	104	44	-	0.42	76	PB	100?	62	56	0.62
64	PB	150	46	40	0.30	57	PB	96?	?	38	-						
70	PB	170	62	?	0.36	60	PB	104?	47	?	0.45						
77	PB	146	40	?	0.27	61	PB	80?	?	37	-						
83	PB	128	45	38?	0.35	62	P	96	51	-	0.53						
						63	B	104?	-	50	-						
						67	PB	134	62	?	0.46						
						71	P	92	41	-	0.44						
						72	PB	116	46	38	0.39						

Tab. 1 - Measurements (in mm) of *Comelicania* specimens from the Southern Alps, grouped into the three distinguished species-groups. Symbols: P) disarticulated pedicle valve; B) disarticulated brachial valve; PB) bivalved shell; Wm) maximum width (hinge width); L) pedicle valve length; Lb) brachial valve length. The specimens are deposited at the Museo Geopaleontologico of the Istituto di Geologia of the University of Ferrara.

Chronological and geographical distribution.

Comelicania was discovered for the first time in the South Tyrol (Southern Alps) from "Bellerophonkalke" by Stache (1878). He cited its occurrence from some localities of the Dolomites and Monte Croce Comelico (Kreuzberg) area. Subsequently, a large collection of fossils from Bellerophon Fm., including many *Comelicania* specimens was collected from the Cadore-Comelico area (Eastern Dolomites) by Caneva (1906 a,b). This collection was studied and published by Merla (1930) in the last extensive work on the Bellerophon Fm. macropaleontology. He recognized 4 of the 5 species created by Stache and introduced 6 new ones. *Comelicania* is also quoted from Recoaro (Merla, 1930) and recently it has been found also in Cordevole Valley and Valsugana (Fig. 3).

The lithostratigraphical setting and the fossiliferous content of the *Comelicania* beds from the Dolomites are given by Broglio Loriga et al. (1986 a,c). According to these Authors *Comelicania* is yielded into a lithological unit made up of black limestone alternated, in the lower part, with black marls. This unit shows a varying thickness from 0.5 to 2 m. It is located in the uppermost Bellerophon Fm., above a unit recording a regressive event and below the oolitical limestone of the Tesero Horizon (Werfen Fm).

The middle-lower part of the *Comelicania* beds bears, among the brachiopods, only *Comelicania*, while in the upper part *Comelicania* is associated with *Ombonia, Orthothetina,* ? *Araxathyris* and *Janiceps*. In the last 10-20 cm of the Bellerophon Fm., *Comelicania* is missing or very rare; only *Ombonia* and *Orthothetina* occur.

Comelicania is missing in some sections probably due to ecological control (e.g. Butterloch and Tesero) (Fig. 3).

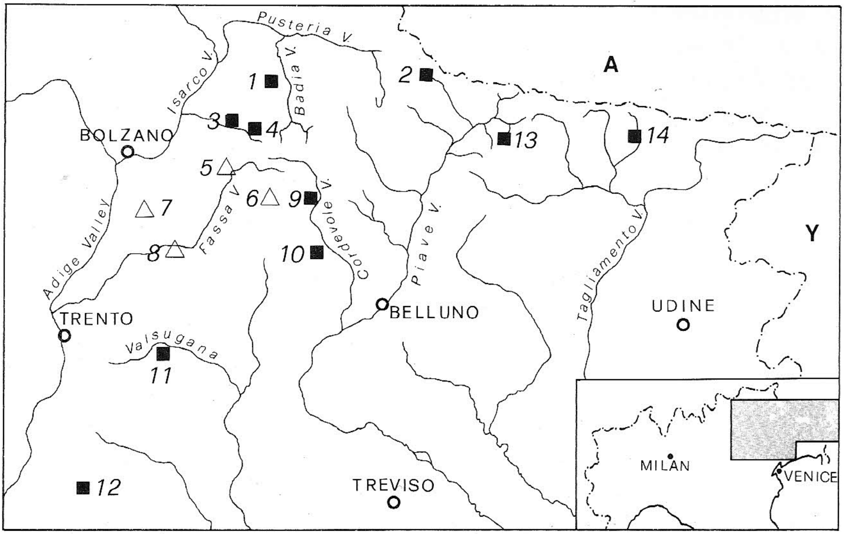

Fig. 3 - Geographical distribution of *Comelicania* in the eastern part of Southern Alps. Black squares) sections with *Comelicania* bearing layers; white triangles) sections without *Comelicania* specimens. 1) Sass de Putia; 2) Monte Croce Comelico (Kreuzberg); 3) Solschedia; 4) Bustaccio; 5) Campestrin; 6) Costabella; 7) Butterloch; 8) Tesero; 9) San Tomaso Avoscan; 10) Agordo; 11) Valsugana; 12) Recoaro; 13) Casera Federata; 14) Paularo. 1-10) Dolomites; 11,12) Venetian Prealps; 13,14) Carnia.

From some sections, where the thickness of the *Comelicania* beds is greater (e.g. Sass de Putia), it seems that *C. haueri* group characterized the lower layers, while *C. megalotis* and *C. ladina* groups are found in the upper ones. In other sections, where the *Comelicania* beds are thinner, all three groups are associated (Valsugana).

In the Bellerophon and lower Werfen Fms., a vertical succession of marine assemblages is distinguished by Broglio Loriga et al. (1986 c). *Comelicania* is found in the *Comelicania* and *Nankinella* Assemblage, which records the highest abundance and taxonomical diversity of the foraminifers and the first occurrence of brachiopods within the formation. Worthy of note is the appearance of foraminifers with stratigraphical value such as *Paraglobivalvulinoides septulifer,* a Dorashamian marker. Molluscs and algae become less frequent with respect to the underlying assemblage.

The *Comelicania* beds of the Southern Alps were correlated, by Assereto et al. (1973), with the *Comelicania-Phisonites* beds from Transcaucasia, now attributed to Lower Dorashamian age. In this way, they supposed the existence of a hiatus between the Bellerophon and Werfen Fms., as the Tesero Horizon was considered entirely belonging to Lower Triassic. According to them, the occurrence of a hiatus would be also proved by sedimentological evidences.

Recently, the founding of un-reworked Permian foraminifers (Pasini, 1985) and mixed-faunae (Neri & Pasini, 1985; Broglio Loriga et al., 1986 b) from the Tesero Horizon have re-opened the question on the P/T boundary and age of *Comelicania* in the Southern Alps. Besides, new data seem to prove a transitional nature of the boundary between Bellerophon and Werfen Fms., both from lithological and paleontological points of view (Broglio Loriga et al., 1986 c). This is supported by the isotopic analysis of $\delta^{13}C$ and $\delta^{18}O$ carried out in the Southern Alps by Magaritz et al. (1988). According to these Authors the isotope profiles at the P/T boundary suggest "that the record of the sedimentation is more continuous and complete in the Alps than in China" (op. cit., p. 378), where we find the sequences considered to be the most complete in the world.

The *Comelicania* beds are made up of bioclastic packstone and grainstone which show an upward coarsening trend and transitionally grade into the overlying Tesero Horizon, base of the Werfen Fm.

The appearance of small ooids occurs in the last centimetre thick layers of the Bellerophon Fm., characterized by the occurrence of *C.* gr. *ladina* with *Ombonia* and *Orthothetina.* The lowermost layers of the Tesero Horizon, showing an upward increasing size of the ooids, yield a mixed P/T fauna. The Permian forms are represented by brachiopods (*Ombonia, Orthothetina*), algae and foraminifers. The two latter groups show a considerable drop in diversity and frequency with respect to the underlying Bellerophon Fm. The "Triassic" forms are represented by relatively frequent specimens of *Bellerophon vaceki* Bittner. This small-size gastropod in the Dolomites shows a vertical range from the base of the Werfen Fm. to the *Claraia aurita* beds (Broglio Loriga et al., 1986 c).

Therefore the first oolitic bank (1-2 m thick) of the Tesero Horizon seems to be the top of a coarsening-up sequence, starting with the bioclastic *Comelicania* bearing limestone, which records a progressive increasing of water turbulence and the appearance of "Triassic" forms.

On the top of this sequence a silty-marly horizon, 10-50 cm thick, is recorded. It yields, in the Tesero section, the *Crurithyris* ? and *Ombonia* Assemblage, characterized by small-size macrofossils in which the last Permian survivors (*Crurithyris? extima* Grant, ? *Spinomarginifera* sp., *Ombonia canevai* Merla, ? *Schuchertella* sp., etc.) are mixed with the Triassic new-comers (*Towapteria scythica* (Wirth) and *Bellerophon vaceki* Bittner). The rhynconellid *Neowellerella* sp. also occurs.

This mixed-fauna reveals strong affinities with the mixed-faunae 1 and 2 from South China, which have been correlated with the *Otoceras* Zone (Lower Griesbachian) by Sheng et al. (1984).

According to all this evidence the contact between Bellerophon/Werfen Fms. seems to be transitional, both from the paleontological and lithological points of view. *Comelicania* beds are located at the base of this sequence, a few metres thick, culminating with a mixed fauna of Lower Griesbachian age. So it is hard to accept a Lower Dorashamian age for the *Comelicania* beds of the Western Dolomites, due to the fact that they are found in a shallow marine environment sequence, without any evidence of a long time gap and with lowermost Triassic fossils at the top. An Upper Dorashamian-Changxingian age is more likely.

Moreover a precise correlation of *Comelicania* from Southern Alps with *Comelicania* and *Phisonites* beds from Transcaucasia cannot be made for two reasons.

- As pointed out by Neri & Posenato (1985) and Broglio Loriga et al. (1986 c), a different composition to species-level occurs: in Transcaucasia only one endemic species occurs, while in the Dolomites 11 species are reported.
- The Transcaucasian comelicaniids differ at genus level from those coming from the Southern Alps.

Central Slovenia (Yugoslavia).

Comelicania haueri was recorded in Central Slovenia by Kossmatt & Diener (1910) from the "Bellerophonkalke" of Schönbrunn (Verzdenec).

Ramovs (1958) subdivided the Zazar beds (= Bellerophonkalke) from the paleontological point of view into 9 bio-horizons (from a to i). *Comelicania* characterizes the fauna g) (*Comelicania* and *Paramarginifera* zone) with the species *C. haueri* (Stache), *C. vultur* (Stache), *C.* cf. *avis* Merla, *C.* aff. *doriphora* Merla and *Comelicania* sp. They are associated with *Notothyris dieneri* Simic, theree subspecies of *Paramarginifera* (= *Haydenella*) *kiangsiensis* (Kayser) and *Marginifera ovalis* Waagen. The lacking of *C. megalotis* and *C. ladina sensu* Merla that in the Dolomites characterize the upper *Comelicania* beds is to be pointed out. So probably the comelicaniids from the fauna g) of the Zazar beds might be older than those from the Dolomites.

No stratigraphical column was given by Ramovs (1958), so the stratigraphical setting with respect to the P/T boundary is unknown. The Zazar beds are attributed to a generical Upper Permian (Ramovs, 1986).

Hungary.

Bükk Mountains.

Only one specimen of *Spirifer (Comelicania) vultur* was recorded from the "Lyttonienkalkstein" in the Bükk Mts. by Schréter (1963).

The outcrop (railway, cut 5, near Nagyvisnyó Village), from which the specimen came, yields a very rich Upper Permian brachiopod fauna, characterized by a great frequency of productids (*Tschernyschewia, Tyloplecta, Spinomarginifera,* etc.). Unfortunately the point at which *C. vultur* was found within the outcrop is unknown.

A recent re-investigation of Schréter's outcrop was made in co-operation with Neri and Csontos. The thickness of the outcrop is about 27 m. It is made up of black limestones alternated with black marls. In the lower-middle part of the sequence the limestones are prevailing over the marls. They are characterized by a rich brachiopod fauna with *Leptodus, Tschernyschewia, Spinomarginifera, Notothyris* and martiniids. Crinoid remains also occur in great abundance. In the upper part the marls become dominant and the productids are more abundant than the other brachiopods. No *Comelicania* specimen was found.

From a comparison of the taxonomical composition, the bulk of the brachiopod faunas show a strong affinity with the brachiopods of Dzhulfian age from Transcaucasia. The attribution of this outcrop to the Lower Dzhulfian stage was recently proposed by Kozur (1985) on the basis of the ostracod assemblage.

Unfortunately, its setting within the sequence and the vertical distance from the Scythian deposits is not known in detail.

Transdanubian Central Range.

Comelicania was found from a borehole from Gárdony (south of Valencia Lake, Central Hungary) in a stratigraphical setting very similar to the Western Dolomites. The lithological unit near the boundary is made up of dark grey limestone followed by oolitical limestone assigned to the Alcsutdoboz Limestone Fm., within which is located the P/T boundary (Barabás-Sthul et al., 1986).

Comelicania is found in a dark grey limestone bed, 50 cm thick. The specimens occur until 10-20 cm below the oolitical layers.

According to Barabás-Sthul et al. (1986) a continuous sedimentation occurs between the Permian and Triassic units. The P/T boundary is placed by the Hungarian Authors within the oolitical beds, about 2 m above the lithological boundary. In this way *Comelicania* is located very close to the P/T boundary, so, it is likely that they belong to the Upper Dorashamian. This likely age is strengthened by the fact that the only one detectable specimen belongs to *C. ladina* group, which also in the Dolomites characterizes the upper *Comelicania* beds.

No further macropaleontological data is available, due to the fact that no outcrop of the P/T boundary is known on the surface in the Valencia Lake area.

Barabás-Sthul et al. (1986), on the basis of microfossils, attribute the *Comelicania* bearing layers to the Dorashamian stage.

Transcaucasia (URSS Armenia and North Iran).

Comelicaniids have been quoted from the ammonoid bearing sequences of URSS Armenia (Dzhulfa area) by Ruzhentsev & Sarytcheva (1965). They are restricted to the *Phisonites* beds only, located above the *Vedioceras-Haydenella* beds and below the "transition beds" (from *Tompophiceras* to *Paratirolites* beds). The comelicaniids are represented by only one endemic species: *Comelicania triangularis* Grunt for which Waterhouse & Gupta (1986) have proposed the gen. *Gruntallina.*

The *Comelicania-Phisonites* beds are characterized by a brachiopod fauna with a low taxonomical diversity. Grunt (in Ruzhentsev & Sarytcheva, 1965) reported only 3 species: *C. triangularis* Grunt, *Janiceps janiceps* (Stache) and *Araxathyris ogbinensis* Grunt.

Very few foraminifers occur in the *Comelicania-Phisonites* beds from Dzhulfa area. Kotljar et al. (1983) quote: *Glomospira* sp., ? *Hemigordius* sp., *Nodosaria* sp., *Geinitzina* sp., etc.

C. triangularis is also recorded from the equivalent beds emerging in Iranian territory near Julfa (Stepanov et al., 1969).

The *Comelicania-Phisonites* beds were considered uppermost Dzhulfian in age, the last Permian stage at that time, while the "transition beds" were attributed to Scythian (Ruzhentsev & Sarytcheva, 1965). Successively the attribution of the "transition beds" changed in favour of an Upper Permian age (Tozer, 1969 ; Teichert et al., 1973). This brought Rostovtsev & Azaryan (1973) to propose a new Permian stage called Dorashamian, including the *Comelicania-Phisonites* beds through *Paratirolites* beds. According to this statement *Comelicania* was considered a marker of the Lower Dorashamian stage.

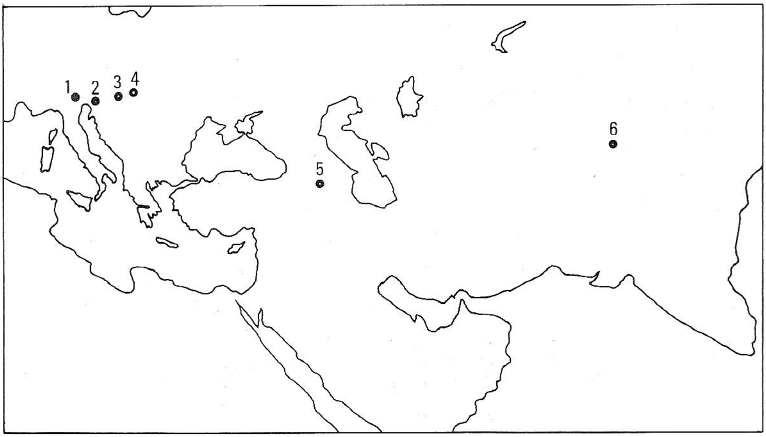

Fig. 4 - Geographical distribution of comelicaniids 1) Southern Alps; 2) Central Slovenia; 3) Transdanubian Central Range; 4) Bükk Mts.; 5) Transcaucasia; 6) Spiti (Himalayas).

Spiti (Himalayas, India).

A new finding of comelicaniids is recorded from the Spiti section (Himalayas) in the uppermost Gungri Fm. (formerly *Productus* or Kuling Shale) by Waterhouse & Gupta (1986).

The comelicaniids are found in a layer 25 cm thick, located 15 cm below the limestone with *Otoceras woodwardi* Griesbach, Lower Griesbachian marker, and above the *Cyclolobus* bearing beds. Specimens of the latter ammonoid come from 0.45, 1.3 and 3 m below the formational boundary.

The specimens have been referred by the quoted Authors to the new genus and species *Spitispirifer bisulcatus*.

The *Cyclobus* beds are referred to Dzhulfian, while *Spitispirifer* beds to Early Dorashamian (or Vedian substage) by the correlation with the *Comelicania-Phisonites* beds of Transcaucasia.

No detailed stratigraphical column of the Spiti section, or faunistic component of the *Spitispirifer* beds is given by the quoted Authors.

Conclusion.

A precise correlation of the *Comelicania* beds from the Dolomites with the classical ammonoid bearing Upper Permian sequences, from Transcaucasia or South China is very hard. It depends on the fact that in the Dolomites the ammonoids as well as other nectonic-planctonic markers are generally missing. Moreover, during the deposition of most of the Bellerophon Fm., restricted and stressed environments occurred in this area, which did not permit the establishment of fully marine communities. So the marine assemblage succession was strongly controlled by local environment evolution rather than chronological factors (Assereto et al., 1973; Broglio Loriga et al., 1986 c).

The lower-middle Bellerophon Fm. has been dated by palinomorphs, ostracods and tetrapod footprints, but large discrepancies occur between the different Authors. According to Kozur (1985) the sedimentation of the Bellerophon Fm. starts during the Lower Abadehian and the bulk of the formation will be Abadehian-Lower Dzhulfian in age. Conti et al. (1986) on the base of extensive research in the Butterloch section (Western Dolomites) propose a younger age. According to them the Bellerophon Fm. in this section ranges from Upper Dzhulfian to Dorashamian-Changxingian in age.

In the Western Dolomites the appearance of fusulinids and other foraminifers with chronological value is seen only in the topmost layers of the Bellerophon Fm. (*Comelicania* and *Nankinella* Assemblage) a few metres (2 - 0.5) below the formational boundary. This assemblage testifies the establishment of the more open marine conditions of the whole Bellerophon Fm. in the Western Dolomites.

A likely Upper Dorashamian age for *Comelicania* and *Nankinella* Assemblage is proposed for the following reasons.

- Transitional nature of the boundary between Bellerophon/Werfen Fms., from lithological, paleontological and geochemical points of view.

- Occurrence of a mixed-fauna at the top *Comelicania* bearing sequences, belonging to Lower Griesbachian.

- Different taxonomical composition -both genus and species level- between the comelicaniids from Southern Alps and Transcaucasia.

It is true that the brachiopod fauna from *Comelicania- Phisonites* beds (Lower Dorashamian) of the Dzhulfa area shows a taxonomical composition similar to the *Comelicania* and *Nankinella* Assemblage from South Tyrol, but the early disappearance of *Gruntallina* and *Janiceps* from Transcaucasia might be caused by local or global environmental alteration of the suitable biotopes. Comelicaniids, *Janiceps* and the associated Permian brachiopods may be survivors in the Westernmost part of the Tethys, until the end of the Permian, as they were settled in shallow marine environments, probably separated by ecological or physical barriers from the oceanic domain. Their occurrence might be testified by the lacking of Upper Permian / Lower Scythian ammonoids in the Southern Alps. So, a relict Lower Dorashamian - like fauna may reach as far as the end of the Permian in the Western Dolomites, with the appearance of particular species, such as *C. megalotis* and *C. ladina sensu* Merla.

Some stratigraphers do not take into account the ecological requirements (i.e. depth, salinity, temperature) or the different bioprovinces of the organisms used as markers and their absence from some areas is seen frequently as a gap in the geological record, even if sedimentological evidence of a break is missing.

The Dorashamian was a time of biological crisis for marine life, but the periods of crisis probably affected the marine communities in the different bio-provinces with different intensity. For example the foraminifers from Transcaucasia and Central Iran (Abadeh) decrease in frequency and abundance earlier than in South China, where abundant microfossil assemblages occur very close to the P/T boundary. Only the last biological crisis was strong enough to extinguish almost all the Permian stenotopic organisms throughout the world.

The Permian survivors, associated with Triassic new-comers characterize the mixed-faunas, which show a low provinciality, which is a typical features of the Scythian fauna. Thus, another crisis affected these mixed communities inducing the final extinction of the Permian stenotopic survivors, including foraminifers, algae and articulate brachiopods.

It left poor, eurytopic, cosmopolitan faunas, typical of the Lower Triassic.

An Upper Dorashamian-Changxingian age is likely for the *Comelicania* from the Gárdony borehole (Central Hungary). The specimens occur near the boundary in the same lithostratigraphical setting as in the Western Dolomites. This age is also supported by the finding of a specimen of the *C. ladina* group.

The comelicaniids from Central Slovenia and Spiti are probably older than those in the Dolomites. In fact from both the localities *C. ladina* and *C. megalotis* are not quoted. Besides in the Zazar beds, above the *Comelicania* and *Paramarginifera* zone, other two bio-horizons were reported by Ramovs (1958), so *Comelicania* bearing layers would not be located very close to the Scythian rocks.

In the Spiti section the contact of the Permian Gungri Fm. with the *Otoceras* beds is not transitional, but a thin (10-20 cm thick) laterite/limonite pebble layer occurs. According to Waterhouse & Gupta (1985) it suggests a hiatus "probably a break in sedimentation and subaereal weathering" (op. cit., p. 219).

On the base of bibliographical references it seems that the Fam. *Comelicaniidae* Merla appears during the Early Dzhulfian in the Bükk Mts. It is not however possible to know if the specimen found by Schréter belongs to the gen. *Comelicania,* due to the fact that its internal features are unknown.

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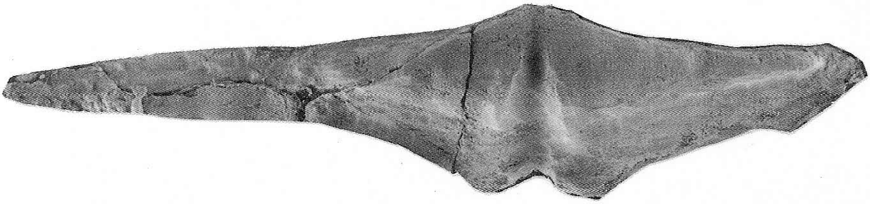
PLATE 50

Fig. 1 - *Comelicania* gr. *haueri* (Stache). Isolated ventral valve from Sass de Putia section. Float from lower *Comelicania* beds; x 1.

Fig. 2 - *Comelicania* gr. *megalotis* (Stache). Complete shell from Sass de Putia section. From layer PK 51 (middle *Comelicania* beds); x 1.

Fig. 3 - *Comelicania* gr. *ladina* (Stache) *sensu* Merla. Isolated ventral valve from Sass de Putia section. From uppermost *Comelicania* beds (layer PK 53); x 1.



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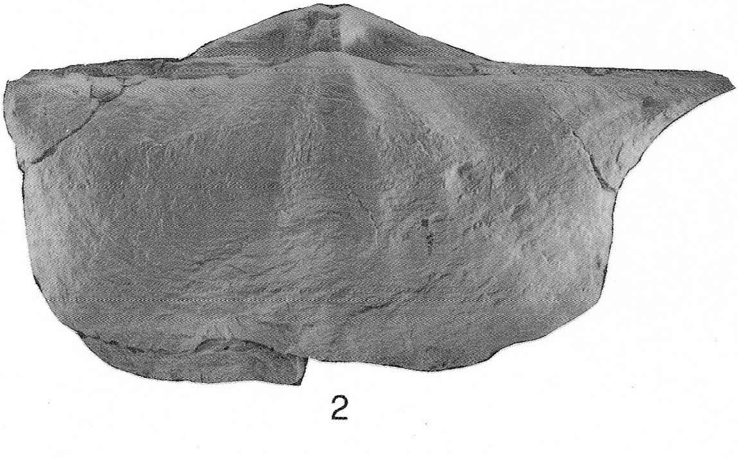

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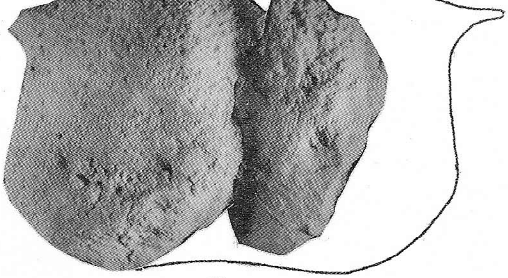

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