82. On the Relation between the Lower Ordovician Trilobites and Conodont Horizons in South Korea

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In South Korea conodonts were first discovered by Müller in 1964 in the Older Palaeozoic rocks. Subsequently Lee (1970) stated that "the Dumugol (i.e. Tomkol) formation contains a mixture of European and subordinate American elements of Arenigian age." Recently he reiterated this age-determination, in describing 20 form-species in 7 genera of the Diastaconodontidae from 4 horizons in the Dongjeom section, Samckeokgun, Kangweon-do. He collected sample 6 and samples 16, 17 and 19 respectively from the very basal part and the 25 meters' top part of the Dumugol shale and limestone alternating beds, about 180 m thick. A long barren intervening part of 150 meters' thickness tells a considerable time-gap. Really *Drepanodus arcuatus* is a sole common element between them. Fourteen short-ranged species particularly noted by Lee are tabulated below.

Thus the selected species are all Tremadocian-Arenigian except for an upper Tremadocian one and three Arenigian ones from the

Conodont species \ Horizon, sample	6	16	17	19
<i>Acodus deltatus</i> Lindström	uT-A			
<i>A. oneontensis</i> Furnish			T-A	
<i>A. tetrahedron</i> Lindström	uT-A			
<i>Acontiodus rectus</i> Lindström	T-A			
<i>A. iowensis</i> Furnish			T-A	
<i>Distacodus stollus</i> Lindström			A	
<i>Drepanodus arcuatus</i> Pander	T-A		T-A	
<i>D. bisymmetricus</i> Viira			uT	
<i>D. homocurvatus</i> Lindström			T-A	T-A
<i>D. parallelus</i> Branson & Mehl			T-A	
<i>Oistodus inaequalis</i> Pander			T-A	T-A
<i>Paltodus inconstans</i> Lindström			T-A	
<i>P. variabilis</i> Furnish			A	
<i>Scolopodus rex</i> Lindström				A
Short-ranged species	4	0	10	3
Total species	5	2	15	3

T: Tremadocian, A: Arenigian, u: upper

top part. Therefore approximate ages of the samples 6, 17 and 19 are judged to be upper Tremadocian, basal Arenigian (or Trem.-Arenig. transition) and lower Arenigian. Although *Prioniodus* or any other compound form was included in the Dongjeom conodonts, their alliance to those of the Latorpian stage, Ninemile formation and D zone of North America may be acceptable for the top assemblages. This means, however, that the sample 6 is much older.

Because no mention is given of the stratigraphic relation of the conodont horizons to the megafossil beds, an attempt is made in order to see how nicely do these horizons fit in the megafossil zonation. As detailed already (1966), the part of the Cambro-Ordovician Chosen group consists of three Ordovician formations and four fossil zones are in descending order as follows:

3. Chiktong limestone, 200 to 400 m thick, with *Clarkella* zone in basal part.
2. Dumugol shale beds, 150-200 m thick. $\begin{cases} \text{Protopliomerops zone} \\ \text{Asaphellus zone} \end{cases}$
1. Dongjeom quartzite, 5-50 m thick, yielding *Pseudokainella* in the northern wing of the Baegunsan syncline.
0. Hwajeol formation about 200 m thick, with *Eoorthis* zone in top part.

It is now thoroughly established that the Fengshanian-Peyntonian trilobite faunas containing *Tsinania*, saukids, etc. on the western Pacific province to which the upper Hwajeol formation belongs, is late Upper Cambrian and pene-contemporaneous with the Trempealeauan on the eastern Pacific side. The Tremadocian age of the Datsonian and Warenian stages superjacent to the Penytanian in Australia is warranted by conodonts (Lu, Chang *et al.* 1964, Kobayashi, 1967, 71, 76, Shergold, 1971, 75). Upper Cambrian age of the Hwajeol formation is also confirmed by conodonts (Lee, 1975).

Fossil zone	<i>Pseudokainella</i>	<i>Asaphellus</i>	<i>Protopliomerops</i>	<i>Clarkella</i>
<i>Pseudokainella</i>	×			
<i>Kainella</i>		×		
<i>Asaphellus</i>		×		
<i>Asaphopsis</i>		×		
<i>Birmanites</i>		×		
<i>Protopliomerops</i>			×	
<i>Dikelokephalina</i>			×	×
<i>Hystriocurus</i>				×

Important trilobites as age-determiners in the above Lower Ordovician formations are shown above. *Kainella* is a Tremadocian genus. In Argentina two species of the genus occur in lower Tremadocian and one and two species of *Pseudokainella* respectively in the lower and upper Tremadocian beds. *Asaphellus* is a typical upper

Tremadoc asaphid in England and Wales, but it occurs in Argentina both in the lower and upper Tremadocian. Therefore, assuming the *Pseudokainella* horizon to be early Tremadocian, the *Asaphellus* zone must be middle or upper Tremadocian. *Apatokephalus* appeared already in the early Tremadocian in Argentina and it became wide spread in North and Central Europe in the late Tremadocian age. Its lower Arenigian occurrence in South France is exceptional. Because *Dikelocephalina* occurs in the *Apatokephalus* zone in Sweden, their association reveals the late Tremadocian age of the *Protopliomerops* zone. In western North America the three *Protopliomerops* zones (F, G₁₋₂) are in the middle part of the Canadian series. Finally, *Dikelocephalina* probably survived in Korea until the early Arenigian in view of its inclusion in the *Clarkella* zone with middle Canadian *Hystericurus*. Judging from these trilobites the *Clarkella* zone in Korea should be early Arenigian.

In Central China lower Tremadocian *Hysteroletetus yuhangensis* Lu occurs below the *Asaphellus-Birmanites* zone in Chekiang. *Asaphopsis* as well as *Birmanites* inclusive of *Birmanitella* are wide-ranged, but *Asaphopsis immanis* and *Asaphellus inflatus* designate two Tremadocian zones, lying the former above the latter in Hupeh (Lu, 1975).

Thus it is warranted at present by regional and global correlations that these Tomkolian trilobites are exclusively Tremadocian. At the same time it is endorsed by the conclusion that the *Tsinania*-bearing Fengshanian-Peyntonian fauna is pre-Tremadocian, instead of Tremadocian (Whittington & Hughes, 1974). Here the relative conodont horizons to the trilobite zones are tentatively tabulated as below.

Age	Trilobites	Conodonts
Arenigian	<i>Clarkella</i> zone	Sample 19 Sample 17 Sample 16
Tremadocian	<i>Protopliomerops</i> zone <i>Asaphellus</i> zone <i>Pseudokainella</i> horizon	Sample 6
Fengshanian	<i>Eoorthis</i> zone	

When so arranged, there is no contradiction against conodont chronology, although the time-relation should be vindicated in the Dongjeom section by their actual field relation. With regard to the conodont frequency it can hardly be overlooked that the basal cono-

dont assemblage is indicated by only 12 specimens in 4 species, but 139 specimens in 16 species from three horizons in the top part of 25 meters within which, remarkable enough, 122 specimens in 15 species were obtained from the middle horizon, i.e. sample 17. This means that the most conodont-rich horizon is within the Tremadocian-Arenigian passage beds. Is it why an Arenigian age emerged already in the preliminary survey? It is not the less noteworthy that *Scolopodus rex* with which Lee (1970) emphasized an Arenigian age of the Dumugol formation is known only from the horizon immediately beneath his Dumugol-Chiktong (his Maggol) boundary. There, however, it is so profused as 6 out of 10 specimens belong to this species. Because the boundary is, lithologically speaking, not so sharp as the base of the Dongjeom quartzite, the boundary is a question. Which is relevant to draw it below or above the *rex*-horizon? Leaving the top part for a future solution, now it can be said that not only megafossils but conodonts also proved the Tremadocian age of the Tomkolian series in the Dongjeom section.

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