VERY LATE FRASNIAN (UPPER DEVONIAN) BRACHIOPOD FAUNA OF *THEODOSSIA SCOPULORUM* ZONE IN THE PALEOEQUATORIAL MACKENZIE SHELF (NWT-CANADA) - WESTERN LAURUSSIA

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ABSTRACT

The "*Theodossia scopulorum* Zone" is an informal Upper Devonian (Frasnian) faunal interval described by Raasch in the 1960s to include the youngest Frasnian carbonate platform shelly faunas in the upper Mackenzie River Valley region, Canadian Rocky Mountains of central and western Alberta and eastern British Columbia. Deposits of the Kakisa Formation in the upper MacKenzie River Valley region yield well preserved shelly faunas of *scopulorum* Zone. The Kakisa is a very Late Frasnian age reef-rimmed carbonate platform sequence package that accumulated in the paleo-equatorial MacKenzie Shelf during Devonian T-R cycle IId-2.

The conodont sequence in the Kakisa with brachiopods and corals of the *scopulorum* Zone indicate correlation with latest Frasnian Montagne Noire Zone 13 of Klapper. The *scopulorum* Zone fauna known from the Kakisa in the NWT and the Graminia Formation and Simla Member of the Southesk formations in the Canadian Rocky Mountains represent the survivor fauna of the initial late Frasnian Lower Kellwasser extinction bioevent in the northern Cordilleran continental margin of western Laurussia.

In the outcrop belt in the along the Kakisa River and the upper MacKenzie River Valley the Kakisa is divided (in ascending order) into members 1 to 3. Skeletal shoal facies of Member 1 along the Kakisa River yield *Theodossia* (*keeni* & *scopulorum*), and distinctive species of *Hypothyridina, Cranaena, Gypidula* and *Pseudoatrypa*. Middle shelf skeletal packstones and wackstones of Member I in the Mackenzie River Valley yield species of *Pseudoatrypa*, *Spinatrypina* (*Exatrypa*), and *Cyrtina.* Subtidal platform facies of the middle Kakisa (Member 2) yield moderately diverse brachiopod assemblages dominated by *Pseudoatrypa,* with species of *Cyrtina, Schizophoria (S.), Cyrtospirifer, Conispirifer,* and *Devonoproductus.* The brachiopod fauna of the reefal facies of Member 3 in the Upper Kakisa includes species of *Theodossia, Gypidula, Desquamatia (D.), Pseudoatrypa, Spinatrypa (S.), Conispirifer, Cyrtospirifer*, and *Cranaena*. None of the brachiopod species of the upper *scopulorum* Zone in Member 3 of the upper Kakisa are known from early Famennian post-extinction survivor faunas and were victims of the very late Upper Kellwasser extinction bioevent.

FIGURE 1.—Late Devonian (Frasnian-360ma) Paleogeographic reconstruction of Laurussia showing location of western Canadian Rocky Mountain study sites (western Alberta, eastern B.C.). Map courtesy of Ron Blakey (2007).

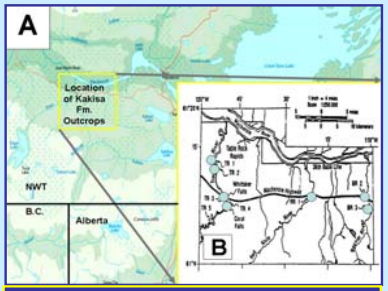

FIGURE 2.–A. Terrane map of part of Alberta, British Columbia (B.C.) and the southern Northwest Territories showing location of the outcrop area of the Late Frasnian age Redknife and Kakisa formations in the Upper Mackenzie River Valley area. B. More detailed map showing locations outcrop exposures of the Kakisa Formation (Amoco Localities, samples housed at the Univ. Alberta) sampled by Amoco geologists and Day. Modified from Klapper and Lane (1985).

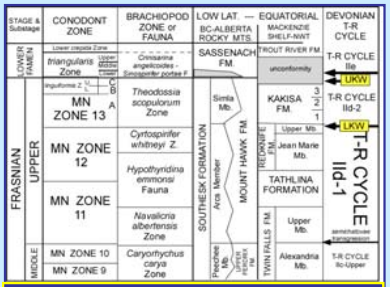

FIGURE 3.—Time Rock Correlation chart of the Middle Frasnian to Lower Famennian rocks in the western Alberta Rocky Mountains and Upper Mackenzie River Valley in the southern NWT (see Figs. 1 and 2 above). The latest Frasnian Theodossia scopulorum Zone includes the faunas of the Kakisa Formation in the southern NWT and Simla Fauna of the Alberta Rocky Mountain outcrops and adjacent areas of eastern British Columbia. Frasnian conodont zones after Klapper (1989, 2007). Brachiopod Zones after McLaren (1954, 1962), Raasch (1968, 1972), and Day (*Hypothyridina emmonsi* Fauna-new data).

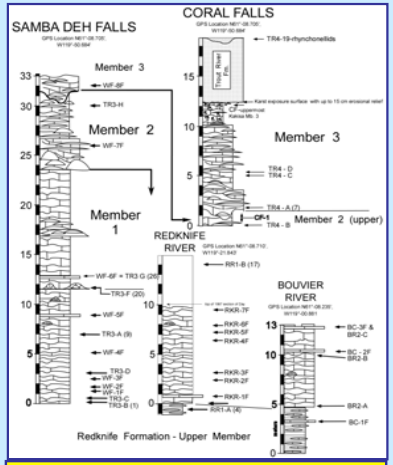

FIGURE 4.—Sections of the Kakisa Formation sampled for megafauna and conodonts along Trout River (Samba Deh Falls = Amoco Locality TR3, and Coral Falls = Amoco Locality TR4 shown in Fig. 2), Redknife River (= Amoco Locality RR1, Fig. 2), and Bouvier River (=Amoco Locality BR2) sampled by Amoco paleontologists in the 1980s, and Day in 1997. Composite range chart of Figure 5 shows local ranges of Kakisa brachiopod taxa in the Kakisa Formation along the upper MacKenzie River Valley outcrop area.

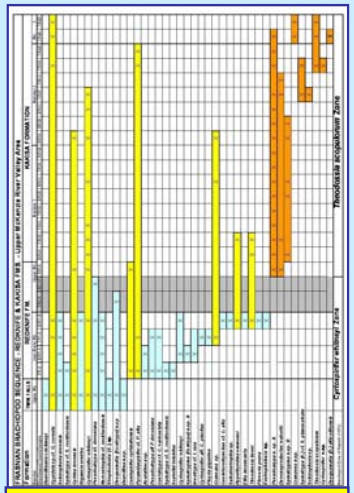

FIGURE 5.--Generalized range chart showing stratigraphic distribution of brachiopod taxa in the Late Frasnian Redknife and Kakisa formations of the southern NWT in samples from sections shown in Figure 4. X symbols denote species occurrence in samples. Colored bars denote local brachiopod species ranges; light blue bars denote species ranging up into position of the Lower Kellwasser Extinction (LKE) event interval (horizontal grey highlighted sample intervals); ranges highlighted in yellow denote species ranging across the LKE into the interval of the *Theodossia scopulorum* Zone; red range bars identify species restricted to and characterizing the interval of the Latest Frasnian *T. scopulorum* Zone.

INTRODUCTION & DISCUSSION

In the study we document the biostratigraphic distribution and illustrate the brachiopod species of the *Theodossia scopulorum* Zone as it is developed in the southern NWT of western Canada (Figs. 1& 2). Most of the species of this distinctive fauna are found in coeval very late Frasnian carbonate platform deposits of the Ronde and Simla members of the Southesk and Graminia formations in the Alberta and BC Rocky Mountains, and the Kakisa Formation in outcrops along the upper Mackenzie River Valley area of the NWT (Figs. 3 & 4). This widespread fauna high in the Frasnian succession of western Canada, and just below the oldest Famennian faunas, provided the basis for Raasch to name this interval the *T. scopulorum* Zone (in Maurin & Raasch, 1972). The name bearer of the zone was first described by Crickmay (1953) who had collected specimens in the Mackenzie River valley area from what was then called the Grumbler Formation (now Kakisa Fm., Figs. 3 & 4).

In the southern NWT, late Frasnian age (Late Devonian) carbonate platform and reefal facies of the members 1 to 3 of Kakisa Formation are exposed along the banks and channels of the Bouvier, Red Knife and Trout rivers in the upper Mackenzie River Valley area (Figs. 2 , 3 & 4), and to the south along the Kakisa River (Fig. 2A). These rocks were sampled stratigraphically for conodonts and brachiopods sampled by Amoco geologists and J. Day in the 1980s and 1990s. Specimens from those collections are illustrated in Figures 6 to 18 below. Conodonts from the Kakisa (Klapper and Lane, 1985) are correlated with most of the latest Frasnian Montagne Noire Zone 13 of Klapper (1989) (Fig. 3).

The fauna of the *scopulorum* Zone of western Canada is highly significant part of the record of the nature of the stepped Kellwasser Extinction bioevents (Frasnian-Famennian Mass Extinction) in the tropical equatorial region of western Laurussia (Figs. 1 & 3). The fauna of the scopulorum Zone is comprised of the survivors of the first extinction (Lower Kellwasser Event = LKE, Fig. 3). In the southern NWT, the estinction of 21 of 29 species (72%) of the Jean Marie Member of the older late Frasnian Redknife Formation became extinct during a major deepening event (Devonian Transgressive Regressive Cycle IId-1 of Day, 1998) and climatic cooling event (Joachimski et al. 2004) associated with the LKE. The LKE occurs within the interval of the Upper Member of the Redknife as shown in Figure 5 by the gray highlighted sample intervals. Regionally, all of the Kakisa fauna of the *scopulorum* Zone underwent extinction and are not known in the Early Famennian fauna of the Trout River Formation (Fig. 4).

The Kakisa fauna of Member 1 (Fig. 5) consists of Redknife carry over taxa (*Schizophoria iowensis*, Fig. 6; *Devonoproductus* cf. *D. walcotti*, Fig. 7; *Hypothyridina emmonsi*, Fig. 15; *Pseudoatrypa* n.sp., Fig. 9; *Cranaena* sp, Fig. 14; *Cyrtospirifer* sp. cf. *C. whitneyi*, Fig. 13; *Theodossia keeni*, Fig. 17) and with first occurrences of *T. scopulorum* (Fig. 18) and *Spinatrypina* (*Exatrypa*) n.sp. (Fig. 11). The fauna of Member 2 of the Kakisa features most species ranging upward from Member 1, with the first occurrences of *Spinatrypa* (*Spinatrypa*) cf. S. *rockfordensis* (Fig. 10) and *Pyramidaspirifer* sp. (Fig. 13-1), and *Cyrtospirifer* sp. cf. *C. whitneyi* (Figs. 13A to C, E & F) in reefal facies in the upper part of Member 2 at Coral Falls in the NWT (Fig. 2).

The reefal Member 3 of the Kakisa is dominated by a diverse rugose coral and stromatoproid fauna, with brachiopods present and abundant in reef cavity fills and shell pavements. Sigificant elements of the Member 3 fauna are *Theodossia scopulorum* (Fig. 18), *Gypidula* sp. (Fig. 14), *Pyramidaspirifer* sp. (Fig. 13-1), and a late migrant from the Eastern European and Russian platform *Desquamatia* (*D.*) *alticoliformis*, *Spinatrypa* (*S.*) *sp. cf. S. rockfordensis* (Fig. 10), *Cyrtospirifer sp. cf. C. whitneyi*.

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FIGURE 6.—*Schizophoria (Schizophoria) iowensis*, from Redknife Fm. Upper Member. A. Interior ventral view of specimen RKR-97-3F; B. posterior view of specimen RKR-97-3F

FIGURE 7.—*Devonoproductus* sp. cf. *D. walcotti*, from Samba Deh Falls, Member 1.
A. ventral view of specimen TR3B-a
B. ventral view of specimen TR3B-b
C. dorsal view of specimen TR3B-c
D. dorsal view of specimen TR3B-d

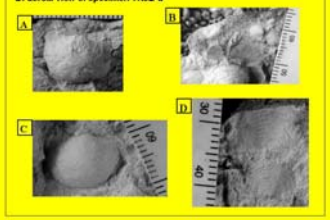


FIGURE 8.—*Desquamatia (Desquamatia) alticoliformis*, from Coral Falls, Member 3
A.dorsal view of specimen TR-4-B #1
B.anterior view of specimen TR-4-B #1
C.Lateral view of specimen TR-4-B #1

FIGURE 9.—*Pseudoatrypa n. sp.*, from Redknife River fm., Upper Member.
A.Dorsal exterior view of specimen WF-97 5F D
B.Posterior dorsal interior view of specimen WF97-5F D
C.Ventral view of specimen WF97-5F A
D.Anterior view of specimen RKR97-4F A

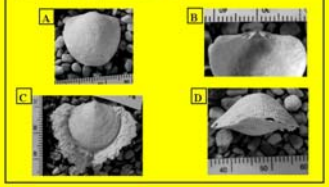


FIGURE 10.—*Spinatrypina (Spinatrypa) cf. S. (S.) rockfordensis*, from Samba Deh Falls (TR3), Member 2.
A.Lateral view of TR3-H #5
B.Anterior view of TR3-H #5
C.Ventral(?) view of TR3-H #3
D.Oblique posterior view of TR3-H #4

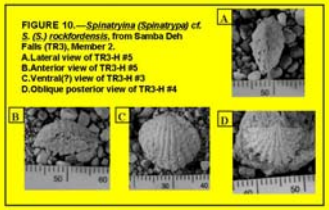


FIGURE 11.—*Spinatrypina (Exatrypa) n. sp.*, from (?) and Redknife River Fm., Upper Member.
A.Dorsal view of BR-97-2F A
B.Dorsal view of RKR-97-3F A
C.Ventral view of RKR-97-3F A
D.Dorsal interior view of RKR-97 5F
E.Posterior view of RKR-97-3F A

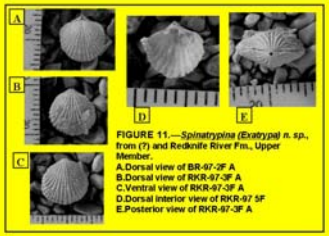
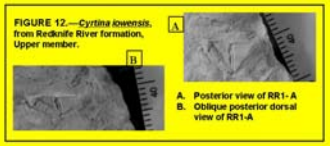


FIGURE 12.—*Cyrtina iowensis*, from Redknife River formation, Upper member.



A. Posterior view of RR1- A
B. Oblique posterior dorsal view of RR1-A

FIGURE 13.—A to C, E & F. *Cyrtospirifer* cf. *C. whitneyi* from Bouvier River, Member 1; D. *Pyramidaspirifer* sp. cf. *P. belenae* from Samba Deh Falls, upper Member 2.
A.Dorsal view of BR3-C
B.Anterior view of BR3-C
C.Ventral view of BR3-C
D.Oblique ventral view of TR3-H-1
E.Anterior view of TR3-H-2
F.Ventral view of TR3-H-2

Figure 14.—*Cranaena sp.*, from Member C., Kakisa Fm.
A.Ventral view of specimen KR-4-B
B.Posterior view of specimen KR-4-B
C.Anterior view of specimen KR-4-B
D.Dorsal view of specimen KR-4-B

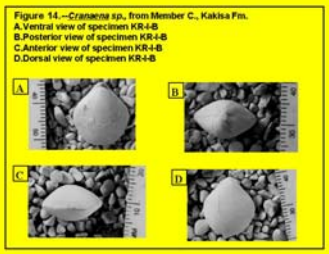


Figure 15.—*Hypothyridina emmonsi*, from (?)
A.Posterior view of MKR-1A-B
B.Dorsal view of MKR-1A-B #1
C.Lateral view of MKR-1A-B #1

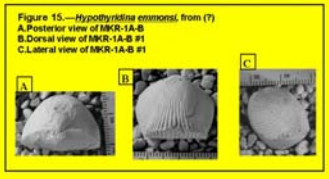


Figure 16 – *Gypidula sp.*, from Coral Falls, Member 3.
A.Ventral view of specimen TR-4-A
B.Posterior view of specimen TR-4-A
C.Dorsal view of specimen TR-4-A

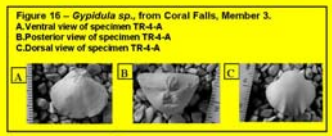


Figure 17
Theodossia keeni
A. Anterior view of specimen PRI 26985
B.Posterior view of specimen PRI 26985

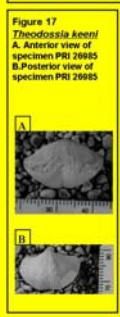
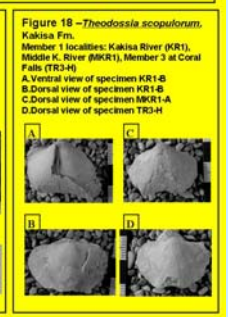



Figure 18 –*Theodossia scopulorum*, Kakisa Fm.
Member 1 localities: Kakisa River (KR1), Middle K. River (MKR1), Member 3 at Coral Falls (TR3-H)
A.Ventral view of specimen KR1-B
B.Dorsal view of specimen KR1-B
C.Dorsal view of specimen MKR1-A
D.Dorsal view of specimen TR3-H