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ABSTRACT

A 21-day visit to China under the scientific exchange agreement between the Australian Academy of Science and Academia Sinica is reported. The visit was part of an earth sciences exchange program on Middle Palaeozoic biostratigraphy and biogeography, and was primarily concerned with Silurian and Devonian vertebrates.

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INTRODUCTION

In November 1981 I was privileged to visit the People's Republic of China under the scientific exchange agreement between the Australian Academy of Science and Academia Sinica. My visit was one of several proposed in an earth sciences exchange program on Middle Palaeozoic biostratigraphy and biogeography, which was approved by the Australian Academy in August, 1981. Other participants in this program are Professor J.A. Talent (Macquarie University), Drs J.S. Jell and G. Playford (University of Queensland), and Dr K.S.W. Campbell (ANU). Talent and Jell visited China in August, 1981, and Campbell and Playford are scheduled to visit China in the first half of 1982.

The specific purpose of my visit was to examine collections of Silurian and Devonian vertebrates, to meet and hold discussions with Chinese specialists in this field, and to establish a basis on which future co-operation and exchange might profitably be pursued. The Middle Palaeozoic vertebrate faunas from South China have attracted considerable attention in recent years, because they are highly endemic with many primitive forms, and because their stratigraphic occurrences do not accord with accepted biostratigraphic zonations for corresponding groups in European and North American sequences. The greater part (13 days) of my visit was spent in Beijing, where the major collections of Palaeozoic vertebrates from China are held in the Institute of Vertebrate Palaeontology and Palaeoanthropology (IVPP), the Institute of Geology (Chinese Academy of Geological Sciences), and the Geological Museum (Ministry of Geology). This was followed by a 3 day field trip to some of the classic vertebrate localities in the Late Silurian/Early Devonian sequences near Qujing, Yunnan Province.

In all, I spent 21 days in the People's Republic, of which 6 were used up in travel between the various centres (Guangzhou, Beijing, Kunming, Qujing). The remaining time was profitably spent examining collections, holding meetings and discussions with Chinese colleagues, and in field work. In addition, my Chinese hosts organised several sight-seeing trips to places of interest in Beijing and its environs. A full itinerary is given in appendix 1.

The scientific success of my visit was in a sense guaranteed by the uniqueness of the Chinese early vertebrate faunas, and also by the fact that a great deal of significant recent work is as yet unpublished, or remains obscure in Chinese language journals. It soon became obvious in my first days at the IVPP, that many of the problems relating to the Chinese faunas which are of current concern to researchers in Australia and Europe have been solved by the Chinese themselves in more recent unpublished work. This information is, of course, of great assistance to me in my research. In reciprocation, however, I was able to identify in their collections a number of groups of Devonian fishes not previously thought to occur in South China, to provide assistance in the resolution of various morphological questions, and to give detailed information on the content of Australian Devonian vertebrate faunas. Perhaps the most significant scientific results of my visit relate to the conclusive demonstration of close affinity between the vertebrate faunas of South China and Australia during certain stages of the Devonian Period. I was also able to give first hand information on recent theoretical developments in biogeographic and phylogenetic analysis, and on the latest publications in the scientific literature of relevance to their studies. There were, however, a number of major publications which had appeared over the last decade, and were essential to the proper investigation of their own faunas, which they were either unaware of or unable to obtain. I am making arrangements to rectify this. I consider, therefore, that my visit was of great mutual benefit in the immediate terms of exchange of current information, and establishment of personal contacts. However, the ultimate success of my visit will depend on the level of future co-operation which results from this initial contact.

It is appropriate that I acknowledge here the hospitality of my hosts during my visit to the People's Republic. Every courtesy and kindness was extended to me, and all arrangements made with a minimum of fuss to permit full use of my limited time. I am particularly indebted to Professor Chow, Professor Liu, Professor Pan, and Professor Gou for making facilities available to me, and for the warm welcome they provided to their respective institutions and/or research laboratories. Drs Zhang Guorui and Liu Shifan gave up almost all their valuable time during my visit to Beijing to assist and accompany me, and this

contributed largely to the success of my visit. Dr Zhang's guidance and knowledgeable introduction to the Devonian geology and palaeontology of the Qujing district made my visit to Yunnan Province a memorable one. Drs Wang Shitao and Hou Hongfei, Messrs Wang Junqing and Yu Xiaobo, Ms Liu Wen Ying and many other colleagues provided assistance with translation and in many other ways. Finally, I acknowledge the Australian Academy of Science and Academia Sinica for making this visit possible.

INSTITUTE OF VERTEBRATE PALAEONTOLOGY AND PALAEOANTHROPOLOGY, BEIJING

This is the central institute for the study of vertebrate palaeontology in China, with over 50 vertebrate palaeontologists on the staff of which 13 are involved in palaeoichthyology. The main vertebrate collections are housed here, and also in a separate museum building which includes public displays. Amongst the many publications put out by the institute is the journal Vertebrata PalAsiatica, and a memoir series on vertebrate palaeontology.

I spent 6 days (5-7, 9-11, 17 Nov.)at the institute studying their collections and holding discussions with colleagues. The collections are impressive and well curated, although a shortage of storage space was evident, and some of the material was inadequately prepared. There was a lack of knowledge on some modern preparation techniques, for example acetic acid digestion and latex casting. However, it was indicated to me that some of the materials required are not easy to obtain.

On the afternoon of the 11th November I visited the IVPP museum, housed in another building several kilometres from the institute. Vertebrate fossils from all over China are displayed in an area covering several floors of the building. Some collections were also stored there (presumably those suitable for display) and a number of conservators and preparators worked in the preparation laboratory. At the time of my visit a number of specimens were unavailable or had been removed from display for casting in connection with a large exhibition of vertebrate fossils from China which was to open shortly in Japan. I was told over 350 specimens were to be sent for this exhibition.

On the afternoon of the 15th November I visited the Chinese Museum of National History. The Director of the IVPP, Professor Chow, is also Director of this museum. All aspects of Chinese natural history are on display for the public, including a range of fossil vertebrates from Agnatha to hominids.

It was unfortunate that I was unable to meet two of the leading researchers in my field from the IVPP. Professor Zhang Miman, who had been at the Swedish Museum of Natural History in Stockholm for some time, extended her visit and had not returned to China. Dr Liu Yuhai, who will be visiting London for two years in the near future, was in Xian for the duration of my visit on an intensive English language course.

MUSEUM OF GEOLOGY, MINISTRY OF GEOLOGY, BEIJING

The Director of the National Museum of Geology, Professor Pan Jiang, is an authority on the Devonian of China, with a special interest in Silurian and Devonian agnathans and fishes on which he has published extensively. The geology museum, together with 8 research institutes, comes under the Ministry of Geology. The museum has a staff of about 140, about one third of which are geologists.

I spent 3 days (12-14th November) at the museum. On my arrival on 12th November I was shown around the museum displays, in several galleries covering about 3 floors of the building. These were impressive and of a very high standard, particularly the modern displays on the history of the earth, and the mineral resources of China. Another display struck me as unusual for a geological museum, and perhaps a manifestation of the long cultural and artistic tradition of the Chinese. An entire gallery was devoted to arts and crafts related in some way to geology, with jewellery, gold and silver work, jade ornaments and utensils and other items carved from stone, and an extensive display of calligraphy on geological themes, and paintings and other works of art and craft done by geologists in their spare time or during field surveys.

The vertebrate collections at the museum were mainly collected by Pan Jiang, who has been particularly active in field work in recent years, and has much new material from South China (Yunnan, Guangxi) and Ningxia. Particularly important from a biostratigraphic viewpoint are the Silurian collections from Yunnan, and the Late Devonian Remigolepis faunas from Ningxia (see appendix).

INSTITUTE OF GEOLOGY, CHINESE ACADEMY OF GEOLOGICAL SCIENCES

I spent one and a half days at the Institute of Geology. Professor Gou (Director) welcomed me on 16th November and summarised the activities of the institute. There is a staff of 290 (177 geologists) in seven divisions: map compilation and geological survey; structural geology; palaeontology and stratigraphy; palaeobotany and palynology; petrology; ultramafics and metallogenesis; geochronology. There are 40 geoscientists in the palaeontology and stratigraphy division, and 31 in palaeobotany and palynology.

The Devonian vertebrate collections are being studied by Dr Wang Shitao. The collections are not large but come from many different localities and stratigraphic horizons. I gathered that much of this material was discovered during the course of geological mapping, although Wang Shitao has re-collected extensively from some regions (e.g. Yunnan, Guangxi). The material includes microvertebrate residues from acid digestion work for conodont recovery. The head of the Palaeontology and Stratigraphy division is Dr Hou Hongfei, an authority on Devonian brachiopods.

FIELD EXCURSION TO QUJING, YUNNAN PROVINCE

On the morning of 18th November, in the company of Dr Zhang Guorui (IVPP), I travelled by air from Beijing to Kunming, where we were met by the head of the Kunming Branch of Academia Sinica, Mr Dai. In the afternoon we were transferred by car to Quijing, about 120 km north east of Kunming, where we stayed until 21 November. A change in airline schedules reduced the field excursion by one and a half days,

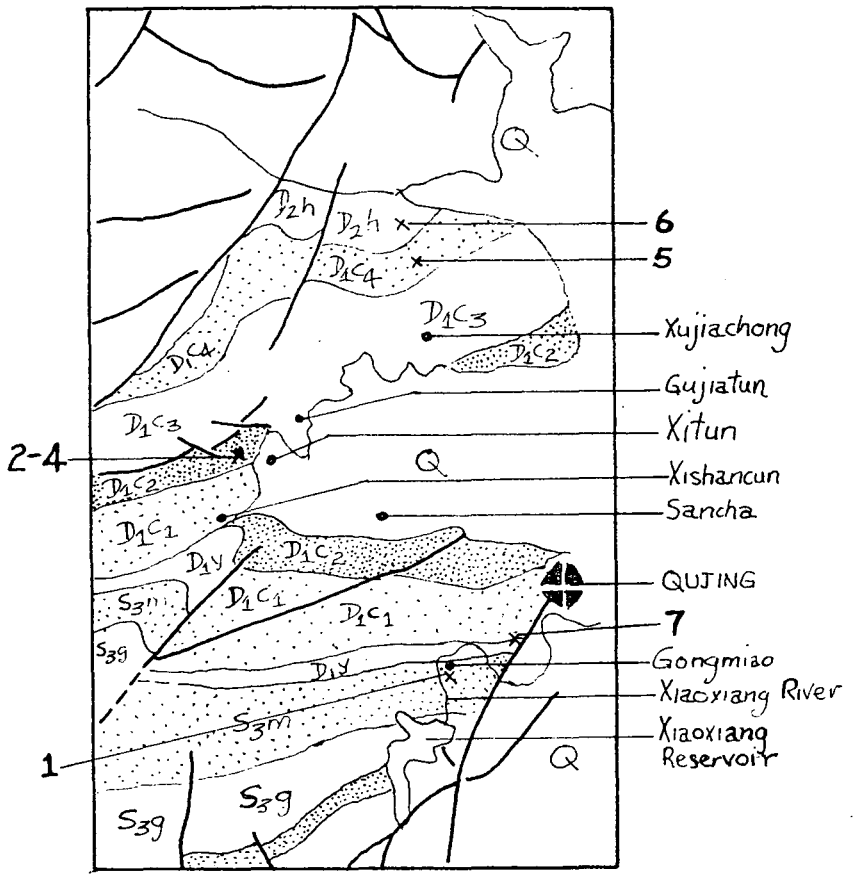
necessitating an early return to Kunming for the flight to Guangzhou on 22 November, instead of 23 November as originally planned. We travelled by road from Qujing to Kunming on 21 November, via Shiling and its 'stone forest' examples of karst topography.

During my visit to Qujing the following sections of Late Silurian-Devonian sediments were examined:

(i) Section below Xiaoxiang reservoir on the Xiaoxiang River (morning of 19 November)

This section begins in the Upper Silurian Guandi and Miaogao Formations, both marine with abundant brachiopods. The beds dip toward the northeast and a traverse was made down river from the reservoir to the village of Gongmiao in the company of Mr Wang, a local geologist, and Zhang Guorui. Pan Jiang's Silurian fish locality was examined. It is on the right side of the valley just below the dam wall, in a yellowish siltstone and reddish mudstone lithology. Only Lingula was observed, suggesting a brackish water deposit in an otherwise marine sequence of limestones and calcareous mudstones. Further downstream was Wang Shitao's Silurian locality (the large trunk-shield of a possible sinolepid) but its precise position was not known to Zhang Guorui. A collection of Silurian brachiopods was made near the village of Gongmiao (these are in the possession of Dr D.L. Strusz, BMR).

According to the geological map (Fig. 1), Pan's locality would be near the boundary between the Guandi and Miaogao Formations, Wang's locality within, and the collected brachiopods from near the top of the Miaogao Formation. However, information provided by Liu Shifan in Beijing (map on NB20) shows both Pan and Wang's localities in the Guandi Formation and Wang stated that his specimen came from the overlying Yulongsi Formation. According to Lin, Guo, Wang et al. (1979, p.16) the Guandi is equivalent to early or middle Ludlow, and the Miaogao to late Ludlow (Pridoli) on the evidence that the overlying Yulongsi Formation contains Warburgella rugulosa sinensis, indicating a basal Lochkovian (Gedinnian) age (see Strusz 1972, p.429). Rong & Yang (1980) have described and discussed the brachiopods from the Miaogao Formation, and they agree with Yang, Pan and Hou (1981, table 4) in placing the Yulongsi Formation as uppermost Silurian. However Yang et al. (1981) note (p.131) that this boundary problem is not yet solved. At Gongmiao village, a black shale horizon was pointed out



GEOLOGICAL MAP OF WESTERN QUJING DISTRICT, YUNNAN PROVINCE

Scale 1:20

MIDDLE DEVONIAN	D_2h	Haikou Fm
LOWER DEVONIAN	Cuifengshan Fm	D_1c_4 Xujiachong member
		D_1c_3 Guijiatum member
		D_1c_2 Xitun member
		D_1c_1 Xishancun member
	D_1y	Yulongsi Fm
UPPER SILURIAN	S_3m	Miaogao Fm
	S_3g	Guandi Fm

Localities 1-7 approximately as shown
(samples from loc. 5 discarded)

Figure 1. Geological map of the western Qujing District, Yunnan Province. Collected specimens come from the numbered localities.

to me in the sections of the surrounding hills, which was said to be either uppermost Silurian or lowermost Devonian. This, presumably, is the Yulongsi Formation.

On our return to Quijing for lunch we stopped at a small road cutting with a similar black shale, where local people had found some fish remains. The locality is down the road from the hotel and around the corner to the left, adjacent to a footbridge and pipeline crossing the road near the cutting. This was a new locality for Zhang Guorui, containing a small antiarch, Yunnanolepis chii, polybranchiaspid, osteolepid and porolepid remains. Specimens collected then and on the following day, presented to me by Dr Zhang, are registered in the BMR vertebrate collection (V1349-1363).

(ii) Xishancun section (afternoon of 19 November)

We were dropped off on a road somewhere between the villages of Xishancun and Sancha, and proceeded west over the hills to Xishancun Reservoir and examined a galeaspid locality in a hard dark grey sandstone on the far side of the dam wall. No specimens were collected. We then returned to our starting point via Xishancun village, and proceeded in a northerly direction in the vicinity of Xitun and Gujiatun villages, where we collected from the main Phymolepis and Yunnanolepis parvus locality (2, Fig.1; registered specimens V1321-1339), a new rhipidistian locality in a greyish mudstone at a small stream crossing (3, Fig.1; registered specimens V1340-1342), and the original Yunnanolepis chii locality (4, Fig.1; specimens V1343-1345). According to Zhang Guorui, localities 2 and 4 are in the Xitun Member of the Cuifengshan Formation (D_1c_2 in Fig.1). We returned to the vehicle past Sancha village.

(iii) Xichong section (morning of 20 November)

We were dropped near Xujiachong village and proceeded up the valley on the left hand side. The section starts in the Guijiatum member (D_1c_3), a red and yellow sandstone unfossiliferous except for a few plant fragments. The overlying Xujiachong member (D_1c_4) is encountered up the valley in the vicinity of the wall for the Xichong Reservoir. This is the uppermost Lower Devonian unit, and contains plant remains. An asterolepid-like skull was said by Zhang to have been

collected by Liu Shifan from sandstones just below the western end of the dam wall, but no further remains were found. Farther up the valley we passed another smaller reservoir, above which the lithology changes to conglomerate near the top of the valley. This marks the beginning of Middle Devonian strata (D_2h), the Haikou Formation (this formation is Givetian on table 4 of Yang, Pan & Hou, 1981, so a disconformity is possible at the Lower/Middle Devonian boundary in the Xichong section). At the top of the valley we collected fragmentary Bothriolepis and rhipidistian remains from a sandstone layer of this formation (loc. 6, Fig. 1); specimens V1346-1348). We continued over the divide into the next valley and a massive limestone terrain, which Zhang said was Middle Devonian, with Hunanolepis collected here by Liu Shifan. However Yang, Pan & Hou (1981,table 4) refer the Zaige Formation (grey massive limestone) to the Upper Devonian.

SUMMARY OF SCIENTIFIC RESULTS

1. AGNATHA

(a) Eugaleaspids and polybranchiaspids

These two groups may be differentiated by the shape of the 'nasohypophysial opening', which is elongated longitudinally in eugaleaspids and transversely (oval shaped) in polybranchiaspids (in Duyunaspis it is circular - see Halstead, Liu & Pan, 1979). The other major difference is the presence of a large ventral plate (and sometimes a smaller separate plate anteriorly) in polybranchiaspids. In eugaleaspids this region is covered by tesserae.

Only 3 eugaleaspids are known: Sinogaleaspis, Yunnanogaleaspis and Eugaleaspis. There are many genera of polybranchiaspids.

(b) Yunnanogaleaspis

This is the only eugaleaspid in which branchial openings are known. There are 7 on each side (see NB13A for illustration).

(c) Latirostraspis

This form is described by Wang, Xia, Chen & Du (1980) from the Silurian Fentou Formation, Anhui Province. It resembles the Devonian

form Hanyangaspis (this name is used, presumably in error, on NB9). The ornament is distinctive, with large tubercles each bearing 5-6 radiating ridges (NB20A). It occurs with marine fossils (trilobites, brachiopods etc) indicating a Middle Silurian age, but Wang et al. (1980) consider a Late Silurian age likely. Latirostraspis is only known from the southeast. It has two ventral plates behind the mouth (NB9). "Sinoszechuanaspis" (see NB20A) may be a related form but this is unclear from the notes. Szechuanaspis was described by Pan, Wang & Liu (1975) from the Lower Devonian Pingyipu Formation of Szechuan (but cf. Yang, Pan & Hou, 1981, p.122).

(d) Upper Devonian Agnatha

Pan has collected specimens with Remigolepis from Ningxia which he regards as agnathans. One specimen I examined resembled the impression of the branchial region of a large agnathan (150 mm or more wide from memory) with more than 10 branchial arches (NB9A).

(e) Anaspids

Liu Shifan has a specimen from the Late Silurian which looks like an anaspid, with 5-6 rows of scales (NB19A).

(f) Thelodontids

Microvertebrate remains from the Baoshan section in the Himalaya-West Yunnan region are of Middle Devonian age (Shangheyunzai Formation - see Yang, Pan & Hou 1981, table 2). Conodonts indicate a late Eifelian/Givetian age. With shark teeth and 'spikes' are thelodont scales, similar to scales of Turinia but with prominent curved spines on each side of the crown of trunk-scales, and head scales with three prominent spines on the base (NB16).

2. ANTIARCHS

(a) Silurian antiarchs.

According to Pan, these are known from 4 localities in E. Yunnan in a red bed unit 30 cm(?) thick underlain by argillaceous limestones and conglomerate unconformable on the Cambrian, and overlain by argillaceous limestones with a brachiopod/coral fauna. Above this are massive quartzites of Early Devonian age. There is also a locality in black shales at the top of the Silurian (cf. specimens collected at Qujing).

The material I examined included a PMD with the posterior pit in front of the crista, an AMD which is less pointed anteriorly than in yunnanolepids, and an impression of a small plate which may have been a MxL (V1349 is a PMD also with the pit in front of the crista).

One Silurian antiarch collected by Wang Shitao is of considerable size. It comes from the Yulongsi Formation (table 4, Qujing section of Yang, Pan & Hou 1981). Only the trunk-shield is known, preserved as part and counterpart of the internal surface. It is broad and flat, about 100 mm in length and breadth, with low lateral walls, and ventral surface unknown. The AMD has distinct lateral corners and is much larger than the PMD. The latter has no well developed pit, but only a slightly roughened and expanded posterior termination of the median groove. The AMD either lacks a pit or it is not preserved, in which case it must have had an anterior position. The MxL has a very broad dorsal and low lateral lamina, and the area behind the crista is expanded ventrally. There is no sign of a separate PL plate, although this is not clear. The posterior dorsal margin of the trunk-shield is concave, as is the posterior crista (for illustration see NB17A).

In general form, and shape of the AMD, this specimen resembles Xichonolepis, although it is not as large. Since ventral plates are absent it is possible that they were much reduced, like Sinolepis and Xichonolepis. This specimen could represent the earliest sinolepid.

(b) Yunnanolepids

The following morphological points came from a study of material at IVPP, and discussions with Zhang Guorui.

(i) In Yunnanolepis chii there is no ornament on the PrM section of the preorbital depression, but in Y. parvus tubercles seem to be present, poking up through the matrix (retouched on Pl.I, fig.1 of Zhang Miman, 1980).

(ii) Zhang (1978, fig.9) presents a different interpretation of the preorbital region of Y. parvus to that of Zhang Miman (1980). Zhang (1978) shows the rostral plate lying in the recess, not behind it, and he suggests (1978, p.154) that the nasal capsules were situated in the recess, and that the nares may have opened anteriorly, as in Remigolepis and unlike Bothriolepis.

(iii) The nuchal plate in Y. chii has paired subnuchal pits behind the openings for the endolymphatic ducts (see NB2; Zhang 1978, pl. 1, fig.3, and V1314).

(iv) The paired semilunar is clear on V4425.2 (Phymolepis - see Zhang 1978 pl.VI, fig. 5) and the notch is clear on AVL's of Y. chii.

(v) The spinal plate figured by Zhang (1980) is unclear, and the suture may be a crack. This specimen (Y. parvus) is very small (total length of head and trunk about 25 mm).

(vi) The plate labelled by Zhang (1980,pl. III, fig.1) as a suborbital is referred to by Zhang (1978) as the opercular plate.

(vii) Some yunnanolepids (?Phymolepis) have an incipient brachial process, whereas the absence of pectoral fin elements in numerous specimens of Y. chii with both head and trunk preserved in relatively undisturbed condition,strongly suggests to Zhang that the fin was unarmoured (but cf. the statement in his diagnosis of family Yunnanolepidae).

(viii) Zhang thinks that the funnel pit and axillary foramen originate from the subdivision of a primitive single opening.

(ix) The posterior pit on the PMD in Qujinolepis and Zhanjilepis lies in front of the posterior internal crista, whereas in Yunnanolepis (e.g. Zhang 1978, fig. 4) it lies behind. Zhang (1978) includes in his family diagnosis a statement that the posterior crista is anteriorly situated. However V1317 shows clearly that the crista subdivides dorsally into two, as in Bothriolepis canadensis (see Stensiö 1948, figs 151, 152), where the anterior thickening supports the median dorsal process of the MxL. It is the corresponding thickening in Yunnanolepis which lies anterior to the pit.

(c) Zhang's comments on yunnanolepid genera erected by Pan & Wang (1978; see also Zhang, 1979).

Eoantiarchilepis = Y. chii

Tsuifengshanolepis = Y. chii

Orientolepis. This form is from Guangxi

Lianhuashanolepis. The AMD figured (Pl.32, fig.1a) is upside down. This is cf.Yunnanolepis.

Hunanolepis. Pan has put this form with the Bothriolepidae.

Hohsienolepis. This form is from Guangxi. Zhang has no opinion on its relationships, although Pan & Wang place it with Wudinolepis.

(d) Dianolepis

Zhang has much unpublished material, including skulls (from memory about 90 mm across) which are clearly bothriolepiform (with a long obstantic margin) except for the PP/LA contact. The preorbital recess in Dianolepis is round, as in B. tungseni. Of the pectoral fin only the ventral surface of the proximal segment is known. It is generally similar to Bothriolepis, but with tubercular ornament, and from memory no marked spine rows. Whether the Cd_2 on the dorsal surface is reduced or not remains an important question. The distal segment is fairly elongate, also tuberculate, and somewhat reminiscent of Sherbonaspis. Sutures are unclear.

Dianolepis occurs with Xichonolepis. AMD's of the former are distinguished by having anterior and posterior divisions of about the same length, and lacking a median ridge on the visceral surface.

(e) Wudinolepis

Again there is much unpublished material and some very elegant reconstructions which Zhang indicated would be published in 1984. The skull has a large semicircular preorbital depression. The suborbital fenestra faces anteriorly into the depression rather than dorsally (hence its reniform rather than oval shape in dorsal view). The suture for the PP is unclear and Zhang admits that it may have been similar to Microbrachius. (NB3 for sketch). There is no specific notebook comment on the trunk-shield and pectoral fin, although these are said (loose note) to indicate bothriolepid affinity, and characters 18-21 on the antiarch cladogram are confirmed.

(f) Microbrachius

Pan has remains of a new species from Givetian rocks in Yunnan (Stringocephalus beds occur both above and below it). The AMD is from memory more elongate than in M. dicki (see NB11A), with an anterior tuberculated area, but elsewhere ornamented with ridges more distinct than the aligned tubercles of M. dicki (e.g. Hemmings, 1978, Pl.7, fig.3). As in M. dicki there is a long overlap area for the ADL. Material

includes PMD, AVL and pectoral fin remains. The AVL has a very straight anterior margin, and a prominent, but single internal crista (NB12). The axillary foramen is large (cf. Hemmings 1978, p.56, who says it is small, although her figs 28, 32, 33 suggest otherwise) and the brachial process is ventral in position.

(g) Bothriolepis

Liu Shifan commented that there are many undescribed species of Bothriolepis. Nobody is working on them. Three species (B. panqiensis, B. longithoraca, B. dashihshansis), mentioned by Liu & Wang (1973) have never been described.

I saw large collections of B. tungseni in Zhang's room at IVPP, preserved in yellowish siltstone similar to the Harajica or Pambula River material. From memory the skulls are small (no more than 60 mm across). Conspicuous are the transverse ridges of ornament on the preorbital region of the skull.

Wang Shitao has a collection from near Xiangzhou, Guangxi Province (just east of locality 19, Fig.2 of Yang, Pan & Hou 1981). Age is Givetian, in the lower member of the Tungkanling Formation (this may be erroneous; Table 3 of Yang, Pan & Hou shows a yellow mudstone, the Changchun Formation, underlying the Tungkanling. This may be the fish-bearing member). The fauna includes a Bothriolepis sp. indet. with a broad PP, associated with Hunanolepis.

Also Givetian is "B. taishanensis" (ms name) from Kwangtung, which is overlain by marine Cyrtospirifer beds. The AMD is fairly large (80 mm long from memory), flat without a median ridge, and with coarse ornament resembling the large Bothriolepis from A4, Antarctica. Overlap areas indicate a curved (convex) anterodorsal margin on the MxL, and the anterior lateral margin of the AMD is also convex (sketch on NB21A).

(h) Hunanolepis

This genus was referred to the Bothriolepidae by Pan & Wang (1978). Wang Shitao has new material from the Givetian Xiangzhou locality, Guangxi, associated with Bothriolepis. One MxL identified as Hunanolepis is very

similar to Bothriolepis, but has ornament of tubercles aligned in rows. Another fragmentary specimen however has typical Hunanolepis ornament (NB15). Pan Kiang has commented that unlike most other placoderms with ridged ornament, the ridges of Hunanolepis are normal to plate margins.

The material from Hunan occurs below the Stringocephalus beds, and is unconformable on Silurian. Age is Givetian. Hunanolepis specimens at IVPP come from Kwangtung and Yunnan. There is no Hunanolepis in Ningxia.

The head of Hunanolepis is unknown. The MxL is only represented in Wang's new material mentioned above.

(i) Xichonolepis

This is a large form, the fairly complete trunk-shield figured by Zang Guorui (1980, Pl.I) being over 200 mm long. In this specimen the impression of the PMD shows clearly that the posterior pit lies behind the internal crista, even though another specimen figured by Zhang Guorui (1980, Pl. II, fig.1) suggests the opposite.

The trunk-shield is shown by this specimen to be broad and low. The right lateral wall is partly preserved (NB4A), showing a long low lateral lamina to the PVL, the absence of a PL, and the MxL resembling that of Bothriolepis rather than Asterolepis in having no contact with the AVL.

Another specimen shows part of the ventral surface (the AVL & PVL were thought by Zhang to be pectoral fin remains). There is a robust distal segment lacking sutures and bearing tuberculate ornament (NB4). In the same specimen an AMD is preserved in visceral view, probably in approximate life position in relation to the ventral plates. Zhang differentiates the AMD from the associated AMD of Dianolepis by its longer anterior division, and conspicuous median ridge on the visceral surface.

The specimen mentioned above, and another figured by Zhang (1980, pl. III, fig.1) demonstrate that the AVL and PVL plates were developed as in Ritchie's Grenfell form.

Wang Shitao has a new PrM similar to the one figured by Pan & Wang (1978, pl. 33, fig. 3). Other material includes pectoral fin elements (a possible Cv_2, which is short and broad, like Asterolepis - see NB20A).

Pan has recently collected cf Xichonolepis associated with Remigolepis from Ningxia. One PMD I examined was large (length ~ 70 mm).

(j) Sinolepis

The specimen figured by Liu & Pan (1958, Pl. VII, fig.2) on examination shows an AVL associated with the skull, demonstrating its affinity with Xichonolepis and the Grenfell antiarch.

(k) Asterolepis

Apart from the Wutung material, in which the suborbital fenestra is much smaller than the orbital fenestra, a character of the genus (NB8), the only asterolepid referred to from China is "?Asterolepis yunnanensis" sp. nov. of Liu & Wang (1973, p.4). This may be the form mentioned by Zhang as a skull with Asterolepis outline collected by Liu Shifan from the uppermost Xujiachong member of the Cuifengshan Formation in the Xichong section (see above). However, if this is the correct locality it is older (Early Devonian) than indicated by Liu & Wang (1973; shown above B. tungseni, i.e. Middle Devonian). When I enquired about this specimen at IVPP Liu Shifan said he was not sure of the determination, but did not show me the specimen.

(l) Remigolepis

The new material from Ningxia comes from five localities and ten horizons. Over 300 specimens were collected by Pan Jiang in 1981. All these horizons are now considered by Pan to be Famennian (cf. Pan 1981, p.70), and the uppermost Remigolepis in Ningxia is 1 metre below Carboniferous fossils.

locality 1: This is the described material (Pan et al. 1980). The PDL is much shorter and higher than the Khan Yunis species.

locality 2: Higher in the section. Ornament is similar to Worange Pt material, and Pan has a complete pectoral fin very much like the one Alex Ritchie collected from the Worange Pt Formation.

locality 3: higher than loc. 2, but perhaps the same species. Subanal lamina appears narrow.

locality 4: a different section. This species is characterised by a very large oval-shaped trunk-shield with a relatively small skull (NB9). From memory skull width was about 60 mm, and trunk width of up to 160 mm. The AMD is broad (b/l index ~100).

locality 5: Two Remigolepis species are represented: a short broad form with short trunk plates, and a short nuchal with a shallow PP notch, as in the Grenfell Remigolepis, and unlike the Khan Yunis forms; and a more elongate form with long AMD, PMD etc. However the PMD in both long and short varieties has a very small circular pit near the posterior margin, in front of which is a short median ridge (NB9A for sketch). It is possible that this is a dimorphic species.
Note: All Remigolepis from Ningxia lack the dlg_2 on the AMD and PDL whereas this sensory groove is present in the Greenland species.

Remigolepis from Hunan: The 6th locality described by Pan is in Hunan, in plant beds (fresh water) with marine calcareous beds containing Yunnanella and Cyrtospirifer both above and below. According to Pan (1981, p.69) these beds correspond to the sandstone member of the Shetienchiao Formation, which Yang, Pan & Hou (1981, pp.134, 136) refer to the Frasnian.

The AMD of this species is very broad (almost round), with a highly characteristic ornament of fine tubercles, widely spaced on an otherwise smooth surface. The nuchal plate is relatively long (NB10 for sketch), and according to Pan Jiang fairly similar to Asterolepis in this respect. One specimen of the skull is recorded in the notebook as having coarser ornament. Fragmentary arthrodiran remains are said to occur with the Remigolepis.

(m) general comments - antiarch phylogeny.

(i) a close relationship is now demonstrated between the Chinese forms Xichonolepis and Sinolepis, and the Grenfell antiarch from NSW.

(ii) The Yunnanolepiformes of Zhang may be paraphyletic, some forms lacking a brachial process and armoured pectoral fin (e.g. Yunnanolepis) and others (e.g. Phymolepis) possessing both.

(iii) The possibility that Pan's Silurian antiarchs may have a mixilateral shows that yunnanolepids can be assumed to represent the primitive antiarch condition on morphological grounds only, and not on their early occurrence.

(iv) It is clear that Dianolepis is the sister group of Bothriolepis, that Wudinolepis is closely related to Microbrachius, and that these are also bothriolepids which have not yet lost the preorbital depression.

(n) general comments - antiarch biostratigraphy

According to Pan there is no Bothriolepis associated with Remigolepis in China. However he suggests this may be due to facies control, since Remigolepis occurs only in redbeds. It is clear from Pan (1981, p.69) that Bothriolepis sp. occurs in beds in Hunan regarded as Famennian. Except for B. tungseni, Dianolepis, and Xichonolepis, which occur in limestone, Bothriolepis generally occurs in terrigenous clastics ('redbeds'? in NB). However Pan considers the limestones also to be freshwater deposits.

(o) general comments - antiarch biogeography

Three major groups of antiarchs are well represented in China:
Sinolepiformes (?Silurian - M.Dev. - L.Dev.)
Bothriolepiformes (?Silurian - M.Dev. - L.Dev.)
Yunnanolepiformes (?Silurian - E.Dev.)

The Asterolepiformes are represented only by two genera (Asterolepis, Remigolepis). Both are confined to the Late Devonian.

3. DOLICHOTHORACIDS

There are two main Lower Devonian localities for arctolepids in South China: (i) Yunnan (?Qujing) material described by Liu Yuhai (1979) as Szelepis.

(ii) The material described by Liu Shifan (1980) from Guangxi as Parawilliamsaspis. This is from Liujing.

Arctolepid material from the Middle Devonian is described by Liu & Wang (1981) from the Haikou Formation in Yunnan, and has been collected by Wang Shitao from Xiangzhou (Guangxi) in Givetian rocks. In both cases only trunk remains are known. In view of Pan's conclusions (see below) regarding the trunk-shield of quasipetalichthyids (skulls of which occur in both assemblages), these determinations may be wrong.

I examined the Szelepis material stored in an outbuilding at IVPP. According to Liu Shifan it comes from the second of the five Lower Devonian divisions (i.e. Xishancun member of Yang, Pan & Hou 1981, table 4). There are only a few specimens well preserved as impressions of inner and outer surfaces. The skull roof pattern could be determined by latexing (cf. Liu, 1979, text-figs). Zhang Guorui pointed out that arctolepids are rare, whereas antiarchs are the predominant placoderms in this fauna.

Wang Shitao has arctolepid material from higher in the Qujing section (Lungwa Mountain), but still Lower Devonian. I examined one impression of the inner surface of a complete trunk-shield (NB21), and a separate MD which is fairly short and broad, and regarded (I think) by Liu Shifan as a brachythoracid. However it resembles the MD of Kujdanowiaspis (Denison 1958, fig.187I) except for its broader anterior margin (NB21 for sketch).

The Guangxi material contains similar endocranial casts to Szelepis according to Lui Shifan, but the AVL's are very different. I briefly examined a few specimens with the Parawilliamsaspis at IVPP, but presume there is other material. The Parawilliamsaspis is an incomplete trunk with a flat ventral surface, like some of the Georgina Basin material. In addition there was a specimen with a long spinal plate similar to Cravens Peak and Dulcie Sandstone material, with a

tuberculate leading edge, behind which is a wide groove and then several longitudinal ridges (see negative 37/10, GB74/12A). This may have been the specimen figured by Liu (1980, fig.2) as "Phlyctaenaspinae indet".

Also from Guangxi, but in Wang Shitao's Middle Devonian collection from Xiangzhou, is a short spine referred by him to the Petalichthyida, but which is possibly a groenlandaspid. However whether both sides were ornamented could not be determined (NB16A for sketch).

4. BRACHYTHORACIDS

(a) Kweichowlepis occurs in the Lower Devonian Wudin Formation in Kweichow, east of Yunnan (see loc 14, Pan 1981, fig.1). This is a red sandstone formation up to 100(?) m thick, disconformable on Silurian, and overlain by the Mazhongling Formation (white quartzite) with many Upper Devonian plants. Above this is marine Late Devonian. Fossils from the upper part of the Wudin Formation include a few brachiopods (cf. Howellella and rhynchonellids) fragments of antiarchs, and Sinopetalichthys, although it is not regarded as a typical marine deposit. I can find no reference to these formations in Yang, Pan & Hou (1981). I was able to point out to Wang Shitao some errors in their reconstruction of this form, and its close similarity to the Australian genus Buchanosteus.

(b) Exutaspis is a new form described by Liu & Wang (1981) as a phlyctaeniid. It is associated with Wudinolepis in the Middle Devonian Haikou Formation (Givetian). Another undescribed form (MS in preparation by Wang Junqing), presumably from the same fauna, is a large skull with a long nuchal, convex posterior margin and dorsal nasal openings (NB7). The PtO and M are wider than in Arenipiscis and more similar in this regard to Coccosteus. The sensory grooves on the central plates have the same arrangement as in Watsonosteus.

(c) Panxiosteus. The skull of this form was unavailable, being cast for the exhibition in Japan. The trunk-shield plates are large heavy bones with coarse ornament of large tubercles. One fragment was similar to the anterior part of the large SM plates from Taemas/Wee Jasper. This form is of Givetian age.

(d). Coccosteid indet. A good impression of a MD visceral surface, with a prominent posterior spine and carinal process is included in Wang Shitao's Xiangzhou material (Givetian, ?Tungkangling Formation, see comments on Bothriolepis and Hunanolepis above). Total length is about 100 mm (NB17 for sketch).

(e) the only brachythoracid of Eifelian age is the large Nu from a marine limestone in Guangxi in Wang Shitao's collection. The ornament resembles Errolosteus although only a single row of tubercles makes up each ridge. The bone is very thick and the Nu was probably similar in proportion to that of Taemasosteus (NB22).

5. QUASIPETALICHTHYIDS

Actinolepid remains were reported by Pan et al. (1980) with Bothriolepis niushoushanensis in the late Middle Devonian of Ningxia. Further collections however have shown that the so-called 'actinolepid' trunk-shield plates are associated only with Quasipetalichthys skulls. The latter were collected in 1981 and were the only specimens I had the opportunity to examine (Liu Yuhai's material was unavailable). Although unprepared, there is little doubt on the basis of skull morphology that they represent the primitive sister-group of petalichthyids, differing only in the absence of paraorbital plates enclosing the orbit. The bone and sensory canal patterns are typically petalichthyid. The sensory grooves are enclosed, with double rows of pits opening to the surface. Ornament is tubercular.

The trunk-plates examined comprised an elongate AVL with AV present and a fairly long spinal plate, generally similar in shape to Kujdanowiaspis (NB11 for sketch).

6. PETALICHTHYIDS

The Early Devonian form Sinopetalichthys occurs with Kweichowlepis. Pan regards this as a freshwater occurrence, although a few brachiopods are associated (see above). The skull specimen was briefly examined. As published illustrations indicate it resembles Macropetalichthys in size and ornament. "Macropetalichthyidae" are also listed in the fauna of the lowermost Miandiancun Formation (Devonian)

in the Qujing section by Yang, Pan & Hou (1981, table 4), and Liu (1981) reports Lunaspis from Guangnan, Yunnan. Xinanpetalichthys is listed from the Pingyipu Formation by Yang, Pan & Hou (1981, table 3, p.122).

Wang Shitao has an undescribed petalichthyid from the Givetian fish fauna in the Xiangzhou section of Guangxi. It is associated with Bothriolepis and Hunanolepis, so it may be non-marine.

7. WUTTAGOONASPIDS

Pan Jiang showed me a putative wuttagoonaspid of Middle Devonian age. The specimen (a poorly preserved skull) was unconvincing and somewhat similar to the 'wuttagoonaspid' of Mark-Kurik (pers. comm.)

8. ELASMOBRANCHS

Wang Shitao has some shark teeth of Eifelian/Givetian age, associated with the thelodonts from the Shangheyunzai Formation in West Yunnan. One tooth was similar to Protacrodus but without distinct cusps, and another had a large central and smaller lateral cusps, tending toward a cladodont condition (NB16 for sketch).

9. RHIPIDISTIANS

Yu Xiaobo is studying rhipidistians. He advised me that he has porolepiforms which lack a choana, this being consistent with the Rosen et al. (1981) criticisms of Jarvik's work. At Qujing I observed both porolepid and osteolepid scale types, and two lower jaw morphologies (NB26) in the lower Devonian (see V1340-1342). Wang Shitao had a small fronto-ethmoidal shield from the Lower Devonian of Yunnan. It is more elongate than in Gyroptychius australis, with sensory grooves well developed. The cosmine is covered with tiny tubercles, as in the Hatchery Creek material, but they are more pronounced. Wang regards this as an osteolepid.

Wang Junqing showed me Middle Devonian material associated with his Exutaspis. This is generally osteolepid in appearance, again with a more elongate fronto-ethmoidal shield than in our Australian species. According to Wang the nasal openings are porolepiform in structure.

Scales are typically osteolepid. Also present in this fauna are larger jaws with grooved teeth.

10. DIPNOANS

The only material examined was that referred to 'Dipterus' in the Sinolepis fauna. However Wang Junqing (1981) recently described a tooth plate as Dongshanodus qujinensis from the marine Zhangyiaying Formation, Qujing, Yunnan (Devonian). In the same paper a dipnoan skull roof from Guangnan, Yunnan is referred to but not described. Rocks of Pragian age occur in this area (Yang, Pan & Hou, 1981, p.135).

11. GENERAL COMMENTS - BIOSTRATIGRAPHY

Galeaspids, antiarchs and acanthodians are now known from the Silurian of South China, and in the Early Devonian rhipidistians, arctolepid (actinolepid) and brachythoracid arthrodires and petalichthyids are added to the faunas. Coccosteomorphs and larger brachythoracids are known from the Middle Devonian, but galeaspids are absent. Otherwise the antiarchs predominate in Middle Devonian faunas. Quasipetalichthyids also appear in the Middle Devonian, although their earlier history is obscure (Neopetalichthys is an Early Devonian form, but its affinites are uncertain).

Late Devonian faunas are dominated by antiarchs (Remigolepis, Asterolepis, Bothriolepis , Sinolepis, cf Xichonolepis), but Pan also has a possible Late Devonian agnathan.

The stratigraphic ranges of the few Chinese dipnoans is unknown and palaeoniscoids have not yet been discovered in their Devonian faunas.

12. GENERAL COMMENTS - BIOGEOGRAPHY

The remarkable South Chinese Devonian fish faunas, although diverse, lack some important groups well represented elsewhere. Groenlandaspids, wuttagoonaspids, phyllolepids, palaeoniscoids, holoptychoids, and onychodontids are some of the groups known from Australian sediments but yet to be recorded in China.

As Wang Shitao pointed out, the thelodontids from West Yunnan do not occur on the South China plate (the locality is west of the Song Ma suture of Ridd, 1971). Of biogeographic significance is the absence from the South China region until the Late Devonian of asterolepid antiarchs, which appear in the Early Devonian in Australia and Euramerica. This points to a possible vicariance explanation for the differentiation of this group. On the other hand the sinolepid antiarchs, known only from China and Australia, indicate close affinity between these regions at least during the Late Devonian. In the Middle Devonian the occurrence of Microbrachius and coccosteids is some evidence of faunal interchange between South China and Euramerica.

It is important to consider separately the Devonian vertebrate faunas from the different tectonic regions of China (Yang, Pan & Hou, 1981, fig. 1; Pan, 1981, fig. 1), since it has been suggested that east Asia generally may have formed by accretion of several smaller continental blocks which remained discrete perhaps until Jurassic time. The highly distinctive galeaspid/yunnanolepid vertebrate fauna occurs predominantly in the South China region. However galeaspids, petalichthyids (Yang, Pan & Hou, 1981, p. 122) and yunnanolepids (Pan, 1981, fig. 1, table 2) are also recorded from the Early Devonian Pingyipu Formation in the Longmenshan-Tsinling region, and Pan (unpublished) has a possible agnathan (?galeaspid) and a sinolepid, from the Late Devonian in Ningxia in the Chiliensh an region (North China block of other authors). In addition Liu Shifan (pers. comm.) mentioned fragments of Hunanolepis from Yumen, Kansu Province, in the northwest part of the Chiliensh an region, but this requires confirmation (Pan has stated that Hunanolepis does not occur in Ningxia). Apart from the Australian sinolepid occurrence, these are the only records of endemic South Chinese taxa outside the South China region.

The southeast China region of Yang, Pan & Hou (1981) differs from South China proper in the absence of Middle Devonian strata (e.g. Pan, 1981, table 2). Liu Shifan regards most of the southeast region as a continental area of non-deposition, but considers the differences between these regions not to be important in terms of vertebrate faunal provinces. Pan pointed out that the area in the Chiliensh an region east of Ningxia is also interpreted as a landmass for the whole of the Devonian. Finally, with regard to the Permian

Lystrosaurus occurrences in North China, it was pointed out that the absence of tetrapods from the South China region is probably due to lack of continental strata. The Permo/Triassic in South China is predominantly a marine sequence.

12. GENERAL COMMENTS - PHYLOGENY

Aspects of antiarch phylogeny were dealt with above. Another major conclusion of phylogenetic significance relates to the quasipetalichthyids, previously of uncertain affinity. As noted above skull morphology now indicates that they are the primitive sister group of petalichthyids. The resemblance of the quasipetalichthyid trunk-shield to that of actinolepids (AV plates, elongate AVL, etc.) strongly suggests a trunk shield of dolichothoracomorph type, thus supporting the phylogeny of Denison (1975), and refuting that of Miles & Young (1977). This evidence is critical to a decision between these alternative hypotheses (Young 1980, p.63). Both petalichthyids and quasipetalichthyids are more primitive than other dolichothoracomorphs in retaining two pairs of paranuchal plates in the skull.

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ZHANG GUORUI, 1980. New material of Xichonolepis qujingensis and discussion of some of its morphological characteristics. Vertebrata PalAsiatica, 18, 272-280 (Chinese with English abstract).

ZHANG MIMAN, 1980. Preliminary note on a Lower Devonian antiarch from Yunnan, China. Vertebrata PalAsiatica, 18, 179-190. (Chinese and English).

APPENDIX 1

Itinerary, 2nd-25th November 1981

Monday 2nd	Flight Canberra-Sydney-Hong Kong (due to bad weather and other factors plane returned to Sydney).
Tuesday 3rd	Flight Sydney-Hong Kong
Wednesday 4th	Visit to China International travel service in morning. Train from Hong Kong to Guangzhou in afternoon. Flight to Beijing in late evening, arriving about midnight.
Thursday 5th	Installed in Friendship Hotel in morning, visited IVPP in afternoon.
Friday 6th	Worked at IVPP
Saturday 7th	Worked at IVPP
Sunday 8th	Visited Great Wall and Ming Tombs with Zhang Guorui and Liu Shifan.
Monday 9th	Worked at IVPP
Tuesday 10th	Worked at IVPP
Wednesday 11th	Visited Summer Palace with Zhang Guorui, Liu Shifan and Pan Jiang (morning). Visited IVPP museum with Liu Shifan and Wang Junqing (afternoon).
Thursday 12th	Visited geological museum (Ministry of Geology)
Friday 13th	Worked at geological museum
Saturday 14th	Worked at geological museum

Sunday 15th	Visited Palace museum, Temple of Heaven and Museum of Natural History.
Monday 16th	Visited Institute of Geology, Chinese Academy of Geological Sciences
Tuesday 17th	Delivered a lecture at IVPP (morning), and studied collections at Institute of Geology (afternoon)
Wednesday 18th	Flight to Kunming with Zhang Guorui, arriving midday. Transfer by car to Qujing, arriving late afternoon.
Thursday 19th	Examined the Upper Silurian stratigraphic section below Xiaoxiang Reservoir (morning). Collected from a new Early Devonian locality on outskirts of Qujing on return to town at midday. Examined the Early Devonian Xishancun section (afternoon).
Friday 20th	Examined the Early/Mid Devonian Xichong section (morning). Collected from the new locality on the outskirts of Qujing in the afternoon.
Saturday 21st	Returned to Kunming by car, via Shiling, arriving late afternoon.
Sunday 22nd	Visited a temple on the outskirts of Kunming overlooking Lake Dian. Flight to Guangzhou at midday (delayed several hours).
Monday 23rd	Sight seeing in Guangzhou
Tuesday 24th	Train from Guangzhou to Hong Kong, arriving midday. Flight from Hong Kong departed 11.30 pm
Wednesday 25th	Arrived Canberra via Sydney at midday.

APPENDIX 2

Personnel met in China

BEIJING

Institute of Vertebrate Palaeontology and Palaeoanthropology

Professor Minchen Chow	Director (mammals)
Professor Liu Hsient'ing	Head, Palaeoichthyology Laboratories (Mesozoic fishes).
Dr Liu Shifan	(arctolepids, paleoclimate)
Dr Su Tetsao	(Mesozoic fishes)
Dr Wang Nien-chung	(agnathans, microvertebrates)
Mr Wang Junqing	(brachythoracids)
Mr Yu Xiaobo	(crossopterygians)
Dr Zhang Guorui	(antiarchs)
Dr Zhang Yuping	(mammals)
Ms Liu Wen Ying	interpreter

Museum of Geology, Ministry of Geology

Professor Pan Jiang	Director (agnathans, placoderms, Devonian biostratigraphy)

Institute of Geology, Chinese Academy of Geological Sciences

Professor Gou	Director (mineralogist)
Dr Wang Shitao	(agnathans, placoderms, Devonian biostratigraphy)
Dr Hou Hongfei	(brachiopods, Devonian biostratigraphy)

Academia Sinica (Bureau of Foreign Affairs)

Mr Shao Ming Xin

KUNMING

Mr Dai Si-Yung	Head of Academia Sinica, Kunming

QUJING

Mr Li	Government official
Mr Wang	local geologist

APPENDIX 3

Scientific specimens and literature obtained during the visit

1. Specimens

Material collected during the field trip to Qujing, Yunnan Province is registered in the vertebrate collections as V1321-1363 (for individual localities see above).

The following copies of type material in the Institute of Vertebrate Palaeontology and Palaeoanthropology and the Geological Museum were presented to me, and are registered in the BMR vertebrate palaeontological collections:

V1312-1320. Phymolepis cuifengshanensis, Yunnanolepis parvus, and Y. chii from Lower Devonian Cuifengshan Formation, Qujing, Yunnan, described by Zhang (1978).

V1364, 1365. Sinolepis macrocephala from the Upper Devonian Wutung Group, Luntang, Nanking, described by Liu & Pan (1958).

V1366. Hunanolepis tieni from the Middle Devonian Tiaomachien Formation, Tiaomachien, Hunan Province, described by Pan & Wang (1978).

V1367, 1368. Yunnanogaleaspis major and Asiaspis expansa from the Early Devonian Cuifengshan Formation in Yunnan and Lianhuashan Formation in Guangxi (Pan & Wang, 1980).

Specimens previously sent by Liu Yuhai (IVPP) are Polybranchiaspis liaojiaoshanensis (V1190), Szelepis yunnanensis (V1191) and Neopetalichthys yenmenpaensis (V1192).

2. Literature

In addition to many specialist reprints the following geoscientific literature on China was presented to me:

Liu Hsient'ing, Liu Yuhai & Wang Junqing, 1981. Translation into Chinese of Moy-Thomas & Miles 1971: Palaeozoic Fishes (Chapman & Hall)

Ren Jishun, Jiang Chunfa, Zhang Zhengkun, and Qin Deyu, 1980. The Geotectonic Evolution of China (Chinese with English table of contents).

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